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FEDERAL NOISE EFFECTS RESEARCH FISCAL YEAR '73 - FISCAL YEAR '75

Environmental Protection Agency
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FEDERAL NOISE EFFECTS RESEARCH
FY 73-FY 75

Prepared by

Interagency Noise Effects Research Panel

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ABSTRACT

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The Noise Effects Research Panel through its collective knowledge of the needs and the current research has identified specific research areas which need additional emphasis in order to provide accurate and thorough information on effects of noise. The Panel concluded that the current programs need continued and in some instances expanded support in order to provide necessary information on the effects of noise. Some areas of concern which are not currently being addressed are also identified.

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I. SUMMARY

Potential effects of noise on the public health and welfare are described, limitations and gaps in necessary knowledge of those effects are identified as research needs, and eight categories for analyzing noise effects research are presented. The current Federal programs are summarized for each of the eight categories, and research needing additional emphasis is identified.

Known or suspected effects of noise discussed included effects on hearing, other effects which may (or may not) lead to permanent health impairment, effects on behavior such as performance or annoyance, speech and other communication interference, sleep disturbance, social/economic/political/legal/behavioral community responses, and effects on animals. Cause-effect relationships, however, have been identified by the Federal government only for hearing, annoyance, and speech interference. The information identified in these three areas is also discussed. Limitations in this information and lack of information in other areas are shown and research needed to provide thorough and accurate information on all effects of noise is identified. Such information is necessary for setting standards for protection of public health and welfare, assessment of the benefits to be derived from noise reduction in light of the costs, assurance of safe, productive work environments and adequate communications, and decisions at all levels affecting the quality of life. A way of categorizing current and needed noise effects research is presented. The current Federally-supported noise effects research is summarized for each of eight categories.

Although an in-depth analysis and assessment of the current Federal noise effects programs is not made, the Noise Effects Research Panel through its collective knowledge of the needs and the current research has identified specific research subjects which need additional emphasis in order to provide accurate and thorough information on effects of noise. These include subjects not currently receiving enough attention and those not currently being addressed. It is further pointed out that the current programs need continued and in some instances expanded support in order to provide necessary information on effects of noise.

II. INTRODUCTION

EPA has established four noise research panels consisting of representatives from Government departments and agencies to provide informational exchange, a forum for interagency discussion, and advice to aid EPA in its role as coordinator of Federal noise research in accordance with the Noise Control Act of 1972. The panels and panel membership reflect the major thrusts of the Federal noise research programs as follows:

Noise Research Panel	Current Agency Membership*
Aircraft	NASA, DOT, DOD, HUD, DOC, EPA
Surface Vehicles	DOT, HUD, DOD, DOC(NBS), EPA
Noise Effects**	HEW (NINDS, NIOSH, NIEHS), DOT, NSF, HUD, NASA, DOD, DOL, DOC(NBS),EPA
Machinery	HEW (NIOSH), DOI(Bureau of Mines), DOD, DOL, DOC(NBS), NSF.

These panels provide the formal mechanisms for interagency consideration, review and assessment of research in the four technical areas. The primary functions of the panels in their respective areas are:

- Review and assessment of the state of science and technology relating to noise.
- Review and assessment of the status of noise research and technology development.
- Identification of technology gaps and research needs.
- Preparation of recommendations concerning ongoing research activities.
- Receipt and review of pertinent scientific and programmatic advice from communicating with other standing bodies and experts in the field of noise.

Noise effects includes not only health effects of noise such as hearing loss, but also many other known or suspected effects of noise on the well-being of humans and animals such as interference with communication, disturbance of sleep, annoyance, and any other results of noise exposure which can affect the quality of life. For the purposes of this report and this research panel, the term "noise effects" does not include effects on structures or other inanimate objects.

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* Glossary of Agency Acronyms in Appendix B.

** List of Noise Effects Panel Members in Appendix C.

A. PURPOSE AND SCOPE

This is the first report prepared by the Noise Effects Research Panel. It will serve as an information base for developing a coordinated national plan for research leading to needed information on the effects of noise. Such information relating the various effects of noise to the physical characteristics of noise exposure such as level, frequency, and duration, as well as to the psychological content of the noise is needed for several reasons. These cause-effect relationships provide the necessary bases for setting standards to protect the public health and welfare, the data for assessing the benefits of noise reduction in light of the costs, and guidelines for personal and Government decisions affecting the quality of life.

A coordinated national plan with the various involved agencies working in cooperation can achieve the following objectives:

- research funds targeted on critical problems and issues
- coordinated and complementary efforts
- research accomplished in the most productive and scientifically viable manner.

To develop such an overall plan, limitations and gaps in the current understanding of the effects of noise must be identified. The current programs must be examined to determine which subject areas are not being adequately addressed. Programs and projects can then be identified for correcting inadequacies and addressing the gaps. The agencies' capabilities for and interests in undertaking these programs and projects can also be determined. Finally, priorities of research needs must be established. Then a national plan for noise effects research can be developed in a meaningful manner. To this end, the report specifically addresses:

- Effects of noise
- Current Federal information on effects of noise
- Limitations in the information and research needs
- A way of classifying noise effects research
- The current Federally-supported noise effects research
- Research needing additional emphasis.

The report does not consider:

- The adequacy of current research
- Detailed programs and projects for addressing gaps

- Capabilities of various agencies for addressing research gaps
- Priorities of research needs
- Development of a coordinated national plan.

This document also will be used by the Environmental Protection Agency to satisfy Section 4(c)(3) of the Noise Control Act of 1972. EPA is required to report on the status and progress of Federal activities relating to noise research and control and to assess the contribution of such activities to the Federal Government's overall efforts to control noise.

Activity for fiscal year (FY)1974 is emphasized, program continuation through fiscal year 1975 is noted where possible, and funding and work carried out during fiscal year 1973 is reported.

The data on which the report is based came from two sources, agencies' responses to a 1972 request* from EPA on Federal noise activities, and information supplied by the panel members in the spring of 1974. The fiscal data is reported consistent with each agency's budgetary process. As there are variations in the way agencies report the costs for their in-house research, exact comparisons between agencies' fiscal data cannot be made. A chart illustrating this problem is contained in Appendix D.

The data for FY 75 estimated funding is incomplete for two reasons. First, the DOD computer data base used to generate the agency fiscal data did not include FY 75 estimates. Therefore, at the DOD panel member's suggestion, the FY 75 levels have been estimated the same as FY 74. Secondly, NSF carries out research only through unsolicited grants. Thus, is it impossible for NSF to predict what research proposals may be received and funded.

Care must also be exercised in examining project and program titles and funding. Titles often do not convey the extent and kind of research being funded and convey no information of the scope of work. Thus, similar titles may involve very different work scopes and furthermore may not mean the subject is being adequately addressed.

Conclusions and recommendations made in this report are the collective opinions of the panel members and do not necessarily represent their agencies' policies.

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*In December of 1972, a questionnaire survey of Federal noise research and noise control activities was initiated by EPA. A contract report was prepared from this data in October 1973 but was not published.

B. EFFECTS OF NOISE

Exposure to noise may have various effects on the public health and welfare. Some of these are well-known but the complexity of both exposure and response has prevented definitive cause-effect relationships in many areas. Other effects are suspected but not yet well-proven.

1. Hearing Damage

It has been well established that noise exposure of sufficient intensity and duration can produce hearing damage. Hearing loss resulting from intense noise exposure can either be temporary or permanent. In general, it is believed that noise of brief exposure that can produce a significant temporary hearing loss or threshold shift is capable of producing permanent hearing loss if the noise exposure is extended in duration or recurrence. That is, daily exposure to a noise which produces a temporary hearing loss presents a risk of permanent hearing loss because the ear may not be able to fully recover to its original threshold from recurrent exposures. The exact relationship between temporary and permanent hearing loss, however, is not yet clearly defined.

Hearing loss which is caused by noise occurs first in the high frequency ranges. This impacts seriously on speech understanding, and good hearing in the higher frequencies is necessary for discriminating the information-carrying, consonant sounds of human speech. Hearing loss is known to result from exposures to: continuous noise in industrial settings, impulsive sound, gunfire, and loud music for extended periods, the last is found especially among young people. The effect from fluctuating, intermittent or shorter-term exposures is not completely understood.

2. Other Health Effects

The only permanent adverse effect upon health from noise exposure that is well-established is noise-induced hearing loss. However, there is evidence, although incomplete, to indicate other effects can result from exposure of sufficient intensity and duration. Noise can alter the function of the endocrine, cardiovascular and neurologic systems. It may effect equilibrium and may produce changes such as: constriction of blood vessels in the body and vaso-dilation in the brain, rise in blood pressure and changes in heart rhythm, and change in rate of stomach acid secretions. Noise also has been shown to produce the same physiological reactions as other stressors, such as emotional stress and pain. There is not clear evidence, however, to indicate that continued activation of any of these responses leads to irreversible changes and permanent health effects.

3. Behavior Effects

When a task requires the use of auditory signals, noise that masks these signals will interfere with the performance of the task. High level continuous noise exposures appear to have potentially detrimental effects on human performance, particularly vigilance tasks, information gathering, and analytical processes. Noise may also increase the variability of work rate and affect the accuracy of work requiring mental concentration. Additionally, noise may be disruptive of performance if the noise is high frequency, intermittent, or unexpected. Noise throughout the audible range can, under various circumstances, be annoying and disruptive of activity. However, prediction of individual annoyance due to noise is difficult, probably due to the many psychological and social factors that contribute to individual sensitivity.

4. Sleep Interference

Noise can interfere with sleep by preventing sleep, by causing awakening, and by changing the level or pattern of sleep. Any of these kinds of interference may have effects on behavior and performance during waking hours as well as long term health effects if repeated. Survey data indicate that sleep disturbance is often the principal reason given for annoyance, and some experts believe that sleep disturbance is one of the most severe effects of noise on health.

5. Communication Interference

In addition to the reduced understanding of speech resulting from noise-induced hearing loss, noise can interfere directly with speech communications. Verbal communication in terms of noise level and vocal effort is extremely difficult in backgrounds of high noise level and can adversely affect the accuracy, frequency, and quality of verbal exchange. This can be important in formal education in schools, occupational efficiency, family life patterns, and quality of relaxation.

6. Community Reaction

The preceding effects of noise all deal with various effects on individuals, although statistical descriptors must be used to average out individual differences in reaction or response. However, when a community of individuals is exposed, a different kind of reaction may take place. This reaction may take several forms such as complaints to authorities, political action against noisy activities, reduction in land values or socio-economic level, high property turnover rates, or changes in family recreational patterns. Thus the consequences of community response to noise can be social, political, and economic, as well as the collective individual responses noted above. To date, only community annoyance responses to aircraft noise have been studied extensively and have been shown to correlate well with noise exposure.

The number of complaints due to noise in a community, however, is small in comparison to the number of people annoyed.

7. Effects on Animals

In general, noise has the same types of effects on animals as it does on humans. Hearing loss and physiologic changes have been noted in laboratory animals. Possible effects on farm animals include changes in size, weight, reproductivity, and behavior. Changes in mating behavior, predator-prey relationships, and territorial behavior have been observed in some wildlife species exposed to noise.

C. CURRENT FEDERAL INFORMATION ON NOISE EFFECTS

There are at present three informational documents relative to health effects from noise exposure which have been published by Federal agencies. The first to be published was "Criteria for a Recommended Standard...Occupational Exposure to Noise" in 1972 by the National Institute for Occupational Safety and Health (NIOSH), Department of Health, Education and Welfare. This was in accordance with Section 20(a)(3) of the Occupational Safety and Health Act of 1970 (29 U.S.C. 656). In 1973, the Environmental Protection Agency published "Public Health and Welfare Criteria for Noise" in accordance with Section 5(a)(1) of the Noise Control Act of 1972 (PL 92-574). In addition, Section 5(a)(2) of the same act called for a document identifying environmental noise level goals. That document, "Information on Levels of Environmental Noise Requisite to Protect the Health and Welfare with an Adequate Margin of Safety" (EPA Levels Document) which was published in March 1974, along with the EPA Criteria Document, are to serve as the basis for establishing standards and regulations called for by the Noise Control Act.

The NIOSH document, specifically directed to the occupational environment, presented information about various effects of noise exposure, but information for support of their recommended standard was available only in the area of noise-induced hearing loss. The EPA "Public Health and Welfare Criteria for Noise" defines criteria as "descriptions of cause and effect relationships." The document addressed direct effects of noise on the physical and mental well-being of human populations, including hearing loss and other health effects, and indirect effects such as annoyance and communication interference, as well as noise effects on wildlife and other animals. Nevertheless, EPA identified only three areas for which criteria exist. According to the EPA Levels Document,

> "There are a multitude of adverse effects that can be caused by noise which may, both directly or indirectly, affect public health and welfare. However, there are only three categories of adverse relationships in which the cause/effect relationships are adequately known and

> can be justifiably used to identify levels of environmental noise for protection of public health and welfare. These are: (1) the effect of noise on hearing, (2) the effect of noise on the general mental state as evidenced by annoyance, and (3) the interference of noise with specific activities."

Although information in these three areas was presented in the EPA Criteria Document and used in the EPA Levels Document, both documents indicated limitations in the information. A short description of the current Federal information in each of the three areas, as contained by the three documents, is presented below.

1. Noise-Induced Hearing Loss

The Criteria Document produced by NIOSH for employee protection during the work period addressed recommendations for a work place standard to protect against hearing impairment. No attempt is made toward the protection of the worker from non-auditory effects of noise exposure; however, the producers of this document have stated that meeting proposed criteria for the protection of auditory effects will reduce the risk of non-auditory effects. Thus, the major aim of this document is to recommend and support a work place noise exposure standard for the protection of hearing, i.e., that the effective noise level permitted during a normal eight hour work period should not exceed 90 dBA for the time being and should be reduced to 85 when technologically feasible. At this time the Department of Labor has proposed a revised standard with the 90 dBA eight hour exposure level and hearing conservation measures beginning at 85 dBA. In support of the NIOSH recommendation, incidence of hearing impairment was compared between noise exposed and non-noise exposed employee groups of comparable ages and experience.

The EPA Criteria Document presented information for predicting permanent hearing loss resulting from exposure to continuous noise of certain levels for eight hours a day over 10 and 40 years. The information, like the NIOSH criteria, also compared noise exposed and non-noise exposed employee groups. Further, like the NIOSH document, the EPA criteria is based only on industrial exposures.

The EPA Levels Document used this information to identify noise levels requisite to protect the human population from significant noise-induced hearing loss with an adequate margin of safety. The levels identified do not include consideration of economic and technological feasibility and thus should not be construed as Federal standards.

In identifying its level for protection against hearing loss, however, EPA found certain limitations in the available data. Thus, EPA had to extrapolate from industrial exposure data to community noise as it affects hearing, from eight hour exposure to 24 hour environmental exposure, and from exposure data mainly above 80 dBA to levels below 80.

2. Community Annoyance

Although community reaction to noise may be evidenced by social or economic measures as well as political or legal action, the available information, as reported in the EPA Criteria Document, deals mainly with statistical surveys of annoyance. The document concluded, among other things, that (1) "the degree of annoyance due to noise exposure expressed by the population average for a community is highly correlated to the magnitude of noise exposure in the community," and (2) "the numbers of complaints about noise registered with the authorities is small compared to the number of people annoyed, or who wish to complain. However, the number of actual complaints is highly correlated with the proportion of people in the community who express high annoyance." The EPA Levels Document used this available information about community annoyance to supplement speech interference data, discussed in the next section.

3. Communication Interference

The EPA Criteria Document identified data which predict fairly accurately how noise will affect the perception of speech in the outdoor environment. The data represents conditions in which talker and listener speak the same dialect and presumably hear normally. The document also indicated that data are available in the literature to suggest a reasonable background noise level for the design of rooms where oral communication is important.

The EPA Levels Document used these data to identify levels of noise requisite to protect public health and welfare against activity interference with an adequate margin of safety, since "the primary effect of noise on human health and welfare due to interference with activity comes from its effect on speech communication." The document also identified speech interference as one of the primary reasons for adverse community reactions to noise and long-term annoyance. It is again important to note that the levels thus identified to protect against activity interference do not include consideration of economic and technological feasibility and thus should not be construed as Federal standards.

D. RESEARCH NEEDS

Although information has been identified and/or used in three Federal documents for three of the many known or suspected effects of noise, the documents plainly pointed out the limitations and deficiencies in the available information. The lack of necessary information on other effects of noise was also discussed as well as the lack of methodologies available to adequately relate the noise exposures to the effects. Even though there are many gaps in today's knowledge on the effects of noise, some states and many local governments are in the process of setting noise limits in regulations/ordinances to reduce noise. Accurate and comprehensive information relating noise and other contributing factors to all its effects is needed to insure that the extent of the reductions is appropriate, and that the reductions may be accomplished with minimum expenditures of public and private money. Such information is also needed to assess the cost of noise reduction in light of benefits and to provide guidelines for personal decisions affecting the quality of life or corporate decisions affecting working conditions. Limitations in or lack of needed information on the various effects of noise are discussed below.

The research needs discussed are for information on which to base protection of public health and welfare in the general sense. It is important to note that in comparing these general needs with the research conducted by the various agencies, it should be remembered that specific agency missions dictate the research that agency conducts and supports, and that specific research projects, while fulfilling an important agency objective, may not be specifically directed toward fulfilling one or more of the general needs discussed below.

1. Noise-Induced Hearing Loss

The current Federal information on noise-induced hearing loss, as presented in both the NIOSH and the EPA Criteria Document and used in support of the NIOSH recommended standard and the EPA identified levels, is based on several cross-sectional industrial studies that have been criticized for various reasons. These criticisms include: insufficient determination of daily noise exposure, problems in or lack of screening for evidence of ear disease, inconsistent test practices, audiological testing in noisy areas, and audiological testing without sufficient time for recovery from temporary hearing loss. The studies also mainly considered continuous eight hour exposures. Thus, there is limited information on intermittent or partial daily exposures and practically no data on exposure to noise beyond an eight hour period. Inconclusive information exists as to whether older people or younger ones are more susceptible to noise-induced hearing loss. Little evidence is available on exposures to various other types of noise, such as impulsive noise, ultrasound, and infrasound. Little is known, also, about the effects on hearing of the combination of noise and other factors such as heat, vibration, and ototoxic (hearing damaging) drugs and chemicals.

2. Health Effects Other Than Hearing Loss

The EPA Criteria Document identified several short-term physiological effects which may result from noise exposure. It is known that noise can elicit different physiological responses, but there is not clear evidence to indicate that continued activation of these responses leads to irreversible changes and permanent health effects. Adequate scientific data are not available to confirm or refute speculations that noise may be a contributor to circulatory difficulties or heart diseases. There are not any well-established data relating noise exposure to fatigue or insomnia, even though it is believed that noise exposure can contribute to these factors. Noise has been considered to be detrimental to the recovery of hospital patients.

Although noise exposure, either alone or in conjunction with other stressors, is presumed to cause general stress, neither the threshold noise level nor duration at which stress may appear has been adequately determined. Further, the effects of chronic noise-produced stress are not known.

Thus, some indicators of potential effects of noise on health have been studied and some have shown definite cause-effect relationships over the short term. Quantitative relationships need to be determined for many indicators of noise effects on health, and all potential effects of noise on health must be studied over the long term. Clear relationships between noise exposure and its potential effects on health must be proved or disproved, so that decisions - government, corporate, or private - may be made on protection of health from noise.

3. Effects on Individual Behavior

Most information available on individual behavior effects of noise concerns either performance or annoyance. Noise is also considered as contributing to other behavior effects such as irritability, instability, argumentativeness, reduction in sex drive, anxiety, and nervousness, but quantitative evidence is lacking in these areas.

Although effects of noise on performance have been shown in the laboratory, little work has been done in real-life situations. As performance effects of noise could be significant and costly in today's economy, there is a pressing need for field studies under typical conditions. The information derived is needed for determining the extent of noise reduction that is cost-beneficial in performance situations.

As individual annoyance in response to noise can lead to the economic or social effects or the political or legal actions discussed under community reaction, as well as to general effects on mental or physical health, a better understanding is needed of the factors that control the degree of annoyance of individuals. Further, as most of the available information on noise/annoyance relationships deal mainly with conventional aircraft noise, annoyance in response to other major sources of noise, as well as new and future aircraft, needs to be determined.

Other behavioral effects of noise mentioned above are less clear-cut and noise is but one of many factors which could contribute to these effects. These effects, however, are serious indicators of reduction in quality of life and could be significant contributors to deterioration of mental and physical health. The relationship of noise to these effects as well as the relative contribution of noise in combination with other causes needs to be determined in order that government, corporate, or private decisions may be made concerning health and the quality of life.

4. Effects on Sleep

Disturbance of sleep by noise resulting in changes in level, patterns, or quality of sleep, or even awakening may affect behavior during waking hours and cause long-term health effects. Most of the available information on effects of sleep interference, according to the EPA Criteria Document, "comes from laboratory experiments that involve very few people, and 'responses' are evaluated in terms of physiological measurements such as EEG" (electroencephalogram, a measure of electrical voltages in the brain). As it is difficult to generalize from the laboratory to real-life conditions, but also very costly to study sleep in everyday settings, both types of studies are needed to develop definitive relationships between noise from various sources and its effects on sleep, both in the short-term and long-term.

5. Communication Interference

The available information concerning a cause-effect relationship for noise interference with speech represents conditions for normally hearing young male adults speaking the same dialect, when they are in a non-reverberant noise field, whereas the actual cause-effect relationship may change with many variables. The EPA Criteria Document states, "lower noise levels would be required if the talker has imprecise speech (poor articulation) or if the talker and the listener speak different dialects. Children have less precise speech than do adults, and their relative lack of knowledge of language often makes them less able to 'hear' speech when some of the cues in the speech stream are lost. Thus, adequate speech communication with children requires lower noise levels than are required for adults. One's ability to understand partially-masked or distorted speech seems to begin to deteriorate about age 30 and declines steadily thereafter. Generally, the older the listener, the lower the background must be for nearly normal communication...it is known that persons with hearing losses require more favorable speech-to-noise ratios than do those with normal hearing." The data available have no information on the reception of female speech or on the effect of time-varying noise on speech understanding. Quantitative data are lacking which show how all these variables affect the relationship between noise and interference with speech.

The available data on speech interference furthermore do not account for the reverberant buildup of sound by reflections from the walls of a room, and thus are not valid for design criteria. According to the EPA

Levels Document, "Recommended values for acceptable sound levels in various types of spaces have been suggested by a number of authors over the past two decades. These recommendations generally have taken into consideration such factors as speech intelligibility and subjective judgments of space occupants. However, the final values recommended were largely the result of judgments on the part of the authors..."

Finally, noise can interfere with the reception of auditory warning signals. However, there are little data to show how loud the signal should be in various noise fields in order to effectively perform its safety function.

Research is needed in order to quantify design criteria which can assure proper reception of speech and warning signals in a variety of situations, e.g., in offices, schools, workplaces, and recreational areas, and for a variety of human characteristics, such as poor or dialectic speech, age, and hearing ability.

6. Community Response

Although information is available relating noise exposure fairly well to community annoyance and resulting complaints to authorities, the data are based mainly on responses to conventional takeoff and landing aircraft noise. The information needs to be expanded to include response to other environmental noise sources, such as vertical or short takeoff and landing aircraft, military aircraft and other vehicles, industrial plants, surface transportation, construction equipment, home appliances, and more. Since annoyance has been shown to lead to complaints, not only does its relation to these other sources of noise need to be studied, but also its relation and the relation of noise exposure to responses such as legal or political actions, change in land values, neighborhood stability, feeling of community, and other social or economic measures. Studies are also needed to determine effect on overall community health and other possible group responses. These relationships are needed to provide input for local government decisions on land-use, corporate decisions on plant location, and private decisions on home and recreational locations, to name a few.

7. Effects on Animals

Although some studies have indicated that noise affects animals in the laboratory in the same way as humans, and behavior changes resulting from noise have been observed in some wildlife species, few quantitative cause-effect relationships have been established. Relationships between noise and changes in reproduction, weight gain, egg and milk production, for example, should be determined so that the economic benefits of reducing the noise exposure of domestic animals may be evaluated. Further, the effect on wildlife is important for preservation of endangered species and conservation and thus should be determined.

8. Measurement

Determination of definitive, quantitative cause-effect relationships demands accurate and reproducible measurement of both cause and effect. Further, the appropriate characteristics of noise must be emphasized in terms of the various effects, but at the same time, inexpensive instrumentation and easily used methods must be available for characterizing the noise environment and for enforcement.

Thus, instrumentation needs to be developed for monitoring noise exposures and standard methodologies developed for characterizing various noise environments and sources in terms of their possible effects. To refine and support hearing loss data, audiometric instrumentation, methodologies, and calibration procedures need to be improved. Finally, a national baseline of community noise levels is needed in order to compare various communities in terms of noise levels and to determine whether the overall national noise levels are improving or deteriorating.

E. RESEARCH CATEGORIES

To address, analyze, and make recommendations effectively on noise effects research in terms of the needs identified above, a system for classifying the research had to be devised. Such a system has been developed by the Noise Effects Research Panel. By consensus, the Panel identified the eight major categories outlined in Table II-1.

Table II-1

CATEGORIES OF NOISE EFFECTS RESEARCH

I. Noise-Induced Hearing Loss
   - A. Epidemiologic
   - B. Human
   - C. Animal
   - D. Mechanisms of Hearing Loss
   - E. Protection

II. Non-Auditory Health Effects
   - A. Epidemiologic
   - B. Human
   - C. Animal

III. Individual Behavior Effects
   - A. Annoyance
   - B. Performance
   - C. Other

IV. Noise Effects on Sleep

V. Communication Interference
   - A. Speech Communication
   - B. Effectiveness of Auditory Warning Signals in the Presence of Noise

VI. Community or Collective Response

VII. Domestic Animals and Wildlife

VIII. Measurement Methodology and Calibration
   - A. Noise Environment
   - B. Noise Source Characterization
   - C. Audiometry

III. SUMMARY OF CURRENT PROGRAMS

The current Federal research programs and projects on effects of noise address all but one of the research categories identified in Table II-1. At the present time there is no ongoing research reported on the effects of noise on domestic animals and wildlife. The funding for research in the other categories, however, is presented in Table III-1. Table III-2 shows the overall effort of each agency in effects of noise, and Table III-3 relates each agency's involvement in categories of research. The following discussions summarize the current effort of the Federal government in addressing the research needs in each category of noise effects research. Each agency's current program is described in Appendix D.

A. NOISE-INDUCED HEARING LOSS

Noise has long been known as a contributor to hearing loss, and many studies in the past few decades have attempted to establish a definitive cause-effect relationship, particularly in the occupational environment. However, the effects of different types of noise and exposure patterns are still not well understood. Variations in susceptibility due to age, drugs, and environmental factors further complicate the problems.

The need for knowledge about noise-induced hearing loss is reflected in the current fiscal data. Almost $1.4 million, over one-quarter of the total Federal expenditures on health effects of noise, was spent on noise-induced hearing loss research in FY 74. Current research programs in this area, carried out by five different agencies, are addressing the following specific problems:

- Cross-sectional studies in various environments (occupational, military, recreational, etc.).
- Relationships between permanent and temporary threshold shifts.
- Susceptibility to hearing loss.
- Combination of noise and other stressors (work, heat, vibration, etc.).
- Combination with ototoxic drugs, other ototoxic agents, and abnormal physiology.
- Effects on children.
- Impulse noise, intermittent noise, and high intensity noise.

Table III-1

NOISE EFFECTS RESEARCH FUNDING BY CATEGORY
(Thousands of Dollars)

Category	FY 73	FY 74	FY 75*
Noise-Induced Hearing Loss	1,084	1,366	1,979
Non-Auditory Health Effects	126	294	61
Individual Behavior Effects	381	361	443
Noise Effects on Sleep	217	254	159
Communication Interference	275	316	296
Community or Collective Response	410	821	1,114
Domestic Animals and Wildlife	0	0	0
Measurement Methodology and Calibration	1,073	1,344	916
TOTALS	3,566	4,756	4,968*

Table III-2

NOISE EFFECTS RESEARCH FUNDING BY AGENCY
(Thousands of Dollars)

Agency	FY 73	FY 74	FY 75*
HEW(NINDS)	526	622	1,157
HEW(NIEHS)	153	258	239
HEW(NIOSH)	395	507	481
DOD	984	930	930*
NASA	1,127	1,154	1,200
DOT	50	130	50
NSF	20	0	0
DOC(NBS)	98	117	142
HUD	117	638	460
EPA	24	377	309
DOI(BuMines)	72	23	0
TOTALS	3,566	4,756	4,968*

*DOD FY 75 Estimated the same as FY 74

Table III-3

CURRENT AGENCY INVOLVEMENT IN RESEARCH CATEGORIES

Research Category \ Agency	HEW(NINDS)	HEW(NIEHS)	HEW(NIOSH)	DOD	NASA	DOT	DOC(NBS)	HUD	EPA	NSF	DOI(BuMines)
Noise-Induced Hearing Loss	x	x	x	x					x	x	
Non-auditory Health Effects		x	x	x					x		
Individual Behavior Effects			x	x		x	x		x		
Noise Effects on Sleep					x				x		
Communication Interference	x			x					x		x
Community or Collective Response				x	x	x		x			
Domestic Animals and Wildlife											
Measurement Methodology and Calibration			x	x	x			x	x		x

- Permanent effects of occupational and longer environmental exposures.

- Mechanisms of hearing loss (biochemical, physiological, etc.).

- Hearing protection.

Funding levels for noise-induced hearing loss research are shown in Table III-4.

B. NON-AUDITORY HEALTH EFFECTS

Many studies have been conducted which tend to indicate noise to be a cause of numerous non-auditory health effects in humans which might influence physical or mental health. These include: orientation and startle reflexes, disturbed sense of balance, pain, and general stress.

One cannot rule out the possibility that noise exposure may pose some non-auditory health hazard if no attempt is made to reduce individual exposure to noise. Caution must be exercised in interpreting the results of studies in this area, however, for controls are exceptionally difficult to exercise. It is also extremely difficult to quantify the non-auditory health effects of noise because of the following complexities and conditions: the wide variety of conditions and mental states involved in personal health; the complexity of the human body and the human mental function; individual and temporal variations in susceptibility to physical and mental health conditions; and the occurrence of noise in combination with other stresses.

Despite many questions that cannot now be answered regarding the non-auditory health effects of noise, Federal expenditures in this category have been modest. Current and recent research in this category, conducted by four different agencies, address the following problems:

- Worker safety and health.

- Susceptibility to mental and physical illness.

- Cardiovascular and other physiological changes.

- Effects on the vestibular (sense of balance), cardiovascular (heart and circulatory), endocrine (internally-secreting glands), and neural systems.

- Effects on drug uptake.

Funding levels for non-auditory health effects research are shown in Table III-5.

Table III-4

FEDERAL RESEARCH FUNDING FOR NOISE-INDUCED HEARING LOSS
(Thousands of Dollars)

Agency	FY 73	FY 74	FY 75
HEW(NINDS)	447	482	1,057
HEW(NIOSH)	224	341	352
HEW(NIEHS)	145	192	199
DOD	248	301	301*
NSF	20	0	0
EPA	0	50	70
TOTALS	1,084	1,366	1,979*

*DOD FY 75 data estimated the sames as FY 74

Table III-5

FEDERAL RESEARCH FUNDING FOR NON-AUDITORY HEALTH EFFECTS OF NOISE
(Thousands of Dollars)

Agency	FY 73	FY 74	FY 75
HEW(NIEHS)	8	66	40
HEW(NIOSH)	108	42	21
DOD	10	0	0*
EPA	0	186 **	0
TOTALS	126	294	61*

*DOD FY 75 data estimated the same as FY 74
**2 year project

C. INDIVIDUAL BEHAVIOR EFFECTS

Individual behavior effects are of interest in a variety of environments where adverse reflex actions or behavior may result in accidents or unfavorable performance, e.g., occupational, military and vehicle handling. Various studies have indicated that noise may have negative, neutral, or even positive effects on performance.

The effects of noise on performance have been studied in the laboratory and in the actual work situation, with more emphasis on laboratory research. Generalizing from the laboratory to real life situations is difficult since, in the laboratory, exposures are short and the novel tasks employed cause subjects to be fairly well motivated. By contrast, office and factory workers usually work below their maximum efficiency and respond to noise in combination with other stimuli. The lack of well-controlled field studies is still a very real problem in the evaluation of the effects of noise on human performance.

Current research programs in this category, conducted by five agencies, are addressing the following specific problems:

- Annoyance factors, e.g., loudness, noisiness, and aversiveness

- Performance capability in:
  - High levels of noise exposure
  - Environmental noise (from transportation systems, etc.)
  - Occupational noise levels
  - Combination with other stressors (heat, vibration, etc.) in various environments

- Startle effects on performance

- Human adaptation to noise

- Measures of aversiveness and annoyance

Funding levels for research on individual behavior effects of noise are shown in Table III-6.

D. NOISE EFFECTS ON SLEEP

Survey data indicate that sleep disturbance is often the principal reason given for noise annoyance.

There are indications that sleeping in noisy surroundings does produce some effects on sleep, either in the form of awakening, if the noise is loud enough, or in the form of shifts in the stages of sleep. Usually, however, much of our data comes from laboratory experiments that involve few people and "responses" are evaluated in terms of physiological measurements such as the electroencephalogram, which measures nervous system electric voltages in the brain. Caution must therefore be exercised in drawing conclusions regarding the effect of noise on sleep for the general population. Even greater caution must be exercised in making references about the long-range effect of sleep disturbance since there exist very little experimental data regarding these effects.

Two agencies reported research directed solely or primarily to noise effects on sleep.

Table III-6

FEDERAL RESEARCH FUNDING FOR INDIVIDUAL BEHAVIOR EFFECTS OF NOISE
(Thousands of Dollars)

Agency	FY 73	FY 74	FY 75
HEW(NIOSH)	0	28	0
DOD	233	166	166*
DOT	50	0	0
EPA	0	50	135
DOC(NBS)	98	117	142
TOTALS	381	361	443*

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*DOD FY 75 data estimated the same as FY 74

Table III-7

FEDERAL RESEARCH FUNDING FOR NOISE EFFECTS ON SLEEP
(Thousands of Dollars)

Agency	FY 73	FY 74	FY 75
NASA	217	254	142
EPA	0	0	17
TOTALS	217	254	159

Current research in this category is being addressed to the following specific problems:

- Nonawakening effects (change in pattern and quality of sleep)
- Sleep disturbance by aircraft noise
- Correlational analysis of foreign and domestic scientific data on the effects of noise on human sleep.

Funding levels reported for research directed solely or primarily to noise effects on sleep are shown in Table III-7, Page 22.

E. COMMUNICATION INTERFERENCE

Noise can interfere with speech by changing its perceived quality, shifting its apparent location or loudness, or by making it partially or completely inaudible.

Unfortunately, most of the available knowledge is often of limited assistance in predicting the intelligibility of ordinary speech which actually consists of a complex sequence of sounds whose overall intensity and spectral distribution are constantly varying. The intelligibility of ordinary speech is rather complex and must often be predicted on the basis of results with isolated words.

Current Federal research in communication interference by noise, conducted by four different agencies, is addressing the following problems:

- Effects of noise on speech production
- Methods for predicting speech intelligibility in noise
- Speech communication in special environments
- Speech discrimination in normal and pathological hearing groups
- Hearing aid performance in noisy environments
- Warning signals in coal mines.

Funding levels for research in communication interference by noise are shown in Table III-8.

Table III-8

FEDERAL RESEARCH FUNDING FOR COMMUNICATIONS INTERFERENCE OF NOISE
(Thousands of Dollars)

Agency	FY 73	FY 74	FY 75
HEW(NINDS)	79	140	100
DOD	124	109	109*
EPA	0	59	87
DOI(BuMines)	72	8	0
TOTALS	275	316	296*

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*DOD FY 75 data estimated the same as FY 54.

Table III-9

FEDERAL RESEARCH FUNDING FOR COMMUNITY OR COLLECTIVE RESPONSE TO NOISE
(Thousands of Dollars)

Agency	FY 73	FY 74	FY 75
DOD	32	0	0*
NASA	378	491	654
DOT	0	130	50
HUD	0	200	410
TOTALS	410	821	1,114*

---

*DOD FY 75 data estimated the same as FY 74.

F. COMMUNITY OR COLLECTIVE RESPONSE

Numerous techniques have also been devised to measure annoyance from a simple scale of annoyance level to complicated techniques involving social surveys. Many studies have addressed the relation between noise and annoyance. Most of this work has been related to conventional aircraft operations. Other noise sources exist which appear to warrant additional consideration. Other social and economic responses such as political actions or change in land values also need to be examined.

Four different agencies were conducting research in community or collective response in the FY 73-74 time period, addressing the following problems:

- National baseline data bank of environmental noise levels-unified measurement system

- Community response studies

- Military operations noise.

Funding levels for research in community or collective response to noise are shown in Table III-9, Page 24.

G. DOMESTIC ANIMALS AND WILDLIFE

Noise produces the same general types of effects on animals as it does on humans, namely: auditory, masking of communication, behavioral, and physiological. These effects have not yet been definitely described. No criteria have been developed for these effects.

Recent research in this category, one project concluded in FY 73, was addressed to hearing levels of fowls. No funding data are listed herein for that project.

H. MEASUREMENT METHODOLOGY AND CALIBRATION

Research in measurement methodology and calibration is conducted by agencies to support noise health effects research programs, to support implementation of noise control legislation, and to maintain a defensible posture regarding measurement technology.

This entails a broad range of activities involved in establishing measurement systems to define the environments and determine the effects on humans: defining measurement requirements, analysis and evaluation of alternate methodologies, and the development of hardware, software and procedures.

The significance of this effort is reflected in the current fiscal data. More than $1.2 million, 28 percent of total Federal funding on noise effects research, was expended on research in measurement methodology and calibration in FY 74. Six agencies conducted research in this category in FY 74, largely directed to the following problems:

- Defining the noise environment through:
  Monitoring methodology
  Monitoring instrumentation
- Noise source characterization - rating schemes
- Audiometry
- Characterization of vertical/short takeoff and landing aircraft noise
- Portable calibration of Audiodosimeters.

Funding levels for research in measurement methodology and calibration are shown in Table III-10.

Table III-10

FEDERAL RESEARCH FUNDING FOR NOISE MEASUREMENT METHODOLOGY AND CALIBRATION
(Thousands of Dollars)

Agency	FY 73	FY 74	FY 75
HEW(NIOSH)	63	96	108
DOD	337	354	354*
HUD	117	438	50
EPA	24	32	0
DOI(BuMines)	0	15	0
NASA	532	409	404
TOTAL	1,073	1,344	916*

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*DOD FY 75 data estimated the same as FY 74

IV. CONCLUSIONS

A. SUMMARY OF DISCUSSIONS

Known or suspected effects of noise include effects on hearing, other effects which may (or may not) lead to permanent health impairment, effects on behavior such as performance or annoyance, speech and other communication interference, sleep disturbance, social/economic/political/legal/behavioral community responses, and effects on animals. Quantitative cause-effect relationships, however, have been provisionally defined by the Federal government only for hearing, annoyance, and speech interference. The information identified in these three areas is also discussed. Limitations in this information in other areas are shown and research needed to provide thorough and accurate information on all effects of noise is identified. Such information is necessary for setting standards for protection of public health and welfare, assessment of the benefits to be derived from noise reduction in light of the costs, assurance of safe, productive work environments and adequate communication, and decisions at all levels affecting the quality of life. A way of categorizing current and needed noise effects research is presented. The current Federally supported noise effects research is summarized for each of eight categories.

B. RESEARCH SUBJECTS NEEDING ADDITIONAL EMPHASIS

Although an in-depth analysis and assessment of the current Federal noise effects programs has not been made, the Noise Effects Research Panel through its collective knowledge of both needs and current research has identified specific research subjects which need additional emphasis in order to provide accurate and thorough information on effects of noise. These include subjects not currently receiving enough attention and those not currently being addressed. They are compared for each category with a summary of the current research (as discussed in Chapter 3) in Table IV-1. Since the adequacy of the current research has not been addressed, it should not be assumed that the subjects listed under current research are being thoroughly covered. On the contrary, the current programs need continued, and in some instances expanded, support in order to provide necessary information on effects of noise.

C. FUTURE PANEL ACTIVITIES

Since the Noise Effects Research Panel has been in existence only a short time, its work has just begun. In the future, it expects to address: adequacy of current research, new starts, agency interests and capabilities, and priorities of research needs. With these activities, the panel hopes to move toward a coordinated plan for Federal noise effects research which can direct research toward critical problems and issues, assure coordinated and complementary efforts, and promote research accomplished in the most productive and scientifically viable manner.

Prior to establishment of the panel in early 1974, the various agencies accomplished much in gaining understanding of the effects of noise. The panel hopes that the overall rate of research progress will accelerate as these agencies participate mutually in this planning process.

Table IV-1

SUMMARY OF NOISE EFFECTS RESEARCH NEEDS BY CATEGORY

I. Noise-Induced Hearing Loss

Current Research	Research Needing Additional Emphasis
1. Cross-sectional studies in various environments, (occupational, military, recreational, etc.)	1. Longitudinal studies of normal hearing
2. Relationships between permanent and temporary threshold shifts	2. Longitudinal studies of noise exposed populations
3. Susceptibility to hearing loss	3. Analysis of cross-sectional and retrospective audiometric data from known occupational exposure
4. Combination of noise and other stressors (work, heat, vibration, etc.)	4. Definition and quantification of presbycusis
5. Combination with ototoxic drugs, other ototoxic agents, and abnormal physiology	5. Possible high-risk and susceptible populations
6. Effects on children	6. Social and economic impact of noise-induced hearing loss
7. Impulse, intermittent, and high intensity noise	

Table IV-1 (Cont.)

Current Research	Research Needing Additional Emphasis
8. Permanent effects of occupational and longer environmental exposures	
9. Mechanisms of hearing loss (biochemical, physiological, etc.)	
10. Hearing protection	

II. Non-Auditory Health Effects

Current Research	Research Needing Additional Emphasis
1. Worker safety and health	1. Non-Auditory long-term health effects a. Epidemiologic (physiological and mental health) b. Longitudinal studies on subhuman primates
2. Susceptibility to disease	
3. Cardiovascular and other physiologic changes	
4. Effects on the vestibular, cardiovascular, endocrine, and neural systems	2. Health effects of impulse noise
5. Effects on drug uptake	3. Health effects of infrasound and ultrasound

III. Individual Behavior Effects

Current Research	Research Needing Additional Emphasis
1. Annoyance - loudness, noisiness and aversiveness	1. Effects on task performance in specific environments
2. Performance capability in: a. High level exposure b. Environmental noise c. Occupational noise d. Combination with other stressors in various environments	2. Pure tone and time-varying corrections for annoyance evaluation 3. Effects of noise in learning situations

Table IV-1 (Cont.)

III. Individual Behavior Effects (Cont.)

Current Research	Research Needing Additional Emphasis
e. Intermittent and impulse noise	4. Annoyance in susceptible populations (e.g., hospital environments)
3. Startle effects on performance	5. Cognitive components of annoying noise

IV. Noise Effects on Sleep

Current Research	Research Needing Additional Emphasis
1. Non-awakening effects	1. Chronic sleep interruption by noise
2. Sleep disturbance by aircraft noise	2. Sleep interruptions on special populations (ill, aged, etc.)
3. Home environment	

V. Communication Interference

Current Research	Research Needing Additional Emphasis
1. Effects on speech production	1. Everyday speech communication in real-life noise situations
2. Methods for predicting speech intelligibility in noise	a. Various vocabularies b. Various populations (children, females, aged, foreign dialect, hearing impaired, etc.)
3. Speech communication in special environments	
4. Speech discrimination in normal and pathological hearing groups	2. Criteria for speech communication in rooms
5. Hearing aid performance in noisy environments	3. Effects of noise on speech and message production
	4. Effectiveness of auditory warning signals in the presence of noise

Table IV-1 (Cont.)

VI. Community Collective Response

Current Research

1. National baseline data bank of environmental noise levels-unified measurement system
2. Community response studies
3. Military operations noise

Research Needing Additional Emphasis

1. Community surveys to address annoyance as a function of exposure patterns
2. Noise, its sociological effects in relation to quality of life
3. Criteria for land use compatibility

VII. Domestic Animals and Wildlife

Current Research

1. Hearing levels of fowls

Research Needing Additional Emphasis

1. Identification and development of criteria with respect to behaviorial effects of:
    - a. Endangered species
    - b. Other wildlife
    - c. Domestic animals

VIII. Measurement Methodology and Calibration

Current Research

1. Noise Environment
    - a. Monitoring methodology
    - b. Monitoring instrumentation
2. Source characterization-noise rating schemes
3. Audiometry

Research Needing Additional Emphasis

1. Development of standard methodologies
2. Characterization of noise in terms of environmental impact
3. Characterization of noise effects of specific sources
4. Development of monitoring instrumentation for evaluation of complex noises

APPENDIX A

GLOSSARY

Term	Definition
Audiometry	The measurement of hearing.
Auditory	Relating to or pertaining to the sense of hearing.
Broad-band Noise	Noise whose energy is distributed over a broad range of frequency.
Cardiovascular	Pertaining to the heart and blood vessels.
Chronic	Long term continuous or frequently repeated.
Cochlea; Cochlear	A spiral shaped cavity in the temporal bone, resembling a snail shell, which forms part of the inner ear and contains the end organ of hearing; pertaining to the cochlea.
Continuous Noise	On-going noise, the intensity of which remains at a measurable level (which may vary) without interruption over an indefinite period or a specified period of time. Loosely, nonimpulsive noise.
Cross-sectional	Pertaining to a sample of a population at a given time.
Decibel (dB)	A measure on a logarithmic scale, of the magnitude of a particular quantity (such as sound pressure, sound power, or intensity) with respect to a standard reference value (20 micropascals for sound pressure).
dBA	A unit of sound level with A-weighted characteristics.
Endocrine	Pertaining to the internally-secreting glands whose products are distributed via the blood rather than through ducts.

Epidemiologic	Pertaining to studies of humans in their natural environment.
Frequency	The number of times per second that a periodic sound repeats itself. Now expressed in Hertz (Hz), formerly in cycles per second (cps).
Hearing Impairment	Hearing loss exceeding a designated criterion (e.g., 25 dB hearing threshold level, averaged from the threshold levels at 500, 1000, and 2000 Hz).
Hearing Loss	Impairment of auditory sensitivity; an elevation of a hearing threshold level.
Hearing Threshold Level	The amount (in decibels) by which the threshold of hearing for an ear (or the average for a group) exceeds the standard audiometric reference zero (ISO 1964; ANSI 1969).
Impulse Noise (Impulsive Noise)	Noise of short duration (typically less than one second) especially of high intensity, abrupt onset and rapid decay, and often rapidly changing spectral composition. NOTE: Impulse noise is characteristically associated with such sources as explosions, impacts, the discharge of firearms, the passage of supersonic aircraft (sonic boom) and many industrial processes.
Infrasound	Sound with frequencies below the audible range, traditionally below 16 Hz.
Intermittent Noise	Fluctuating noise whose level falls one or more times to very low or unmeasurable values during an exposure.
L_{dn}	A one-number scheme for designating the 24-hour equivalent noise exposure adjusted so that nighttime noise is given more weight.

Level	In acoustics, the level of a quantity is the logarithm of the ratio of that quantity to a reference quantity of the same kind. The base of the logarithm, the reference quantity, and the kind of level must be specified.
Longitudinal Studies	Long-term surveying and monitoring of a given group of the population.
Noise Exposure	A combination of effective noise level and exposure duration.
Noise-Induced Permanent Threshold Shift (NIPTS)	A permanent threshold shift (PTS) caused by noise exposure, corrected for the effect of aging.
Ototoxic	Poisonous or damaging to the auditory (hearing) organ.
Permanent Threshold Shift	A permanent elevation in the hearing threshold level.
Physiological	Pertaining to the functions and activities of a living cell, tissue or organism.
Sound Level (SL)	Weighted sound pressure level, obtained by the use of metering characteristics and the weightings A, B, or C as specified in the American National Standard Specification for Sound Level Meters, ANSI-S1.4-1971. The weighting employed must be stated.
Temporary Threshold Shift (TTS)	A short duration elevation in the hearing threshold level.
Threshold of Hearing	The minimum effective sound pressure level of an acoustic signal capable of exciting the sensation of hearing in a specified proporation of trials in prescribed conditions of listening.
Ultrasound	Sound with frequencies above the audible range, i.e., above 16,000-20,000 Hz.
Vestibular	Pertaining to the sense of balance organs in the inner ear.

APPENDIX B

GLOSSARY OF AGENCY ACRONYMS

Symbols	Agencies
DOC	Department of Commerce
DOC(NBS)	National Bureau of Standards
DOD	Department of Defense
DOI	Department of the Interior
DOI(BuMines)	Bureau of Mines
DOL	Department of Labor
DOT	Department of Transportation
EPA	Environmental Protection Agency
HEW	Department of Health, Education, and Welfare
HEW(NIEHS)	National Institute of Environmental Health Sciences
HEW(NINDS)	National Institute of Neurological Diseases and Stroke
HEW(NIOSH)	National Institute for Occupational Safety and Health
HUD	Department of Housing and Urban Development
NASA	National Aeronautics and Space Administration
NSF	National Science Foundation

APPENDIX C

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APPENDIX D

DESCRIPTION OF PROGRAMS AND PROJECTS

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DESCRIPTION OF PROGRAMS AND PROJECTS

This appendix presents a summary of Federal research programs and projects in noise effects.

Program and project information is grouped according to agency and, within each agency, according to research categories.

The fiscal data are reported for each agency consistent with its own budgetary process. As there is considerable variation among the various agencies in such processes, comparison of funding levels cannot be made. Table D-1 illustrates this difficulty by showing what is included in each agency's funding reporting.

The project and program titles reported convey little information on scopes of work. Thus similar titles may have widely varying funding levels and may involve completely different kinds and extent of research activities.

Table D-1

IN-HOUSE RESEARCH COST ITEMS BY AGENCY

	Agency									
Cost Items	NINDS	NIEHS	NIOSH	DOD	NASA	NBS	EPA	HUD	DOT	NSF
EQUIPMENT AND SERVICES	X	X	X	X	X	X	X			
SALARIES	X	X	X	X*	X	X				
FRINGE BENEFITS	X	X	X	X	X	X	X			
ADMINISTRATIVE		X		X	X	X	X			
FACILITIES		X		X	X	X				
TRAVEL		X	X	X	X	X	X			
NO CURRENT IN-HOUSE RESEARCH IN NOISE EFFECTS								X	X	X

*Civilian salaries included, but not military salaries

1. NINDS

NINDS has major research efforts on-going in two categories, noise induced hearing loss and communication interference, and plans to initiate a major effort in a third category, nonauditory health effects.

1.1 Noise Induced Hearing Loss

NINDS has three organizational divisions which relate to noise-induced hearing loss, and ten specific projects (some in the planning phase) dealing with that research category. The program-project relationship and funding are shown in Table D-2.

Effects of Noise on People - The NINDS program, Effects of Noise on People, is part of the directed research program in Communicative Disorders which has as its overall goal the diagnosis, treatment, amelioration, and prevention of communicative disorders. The thrust of the noise program is best understood in the context of the other major program areas which include hearing, sensory aids for the communicatively handicapped, and language and speech problems of children and adults.

Specific noise-related goals include: prevention of handicapping conditions in young children which are attributable to noise exposure; improved understanding of the economic and social impacts of noise-induced hearing loss; improved understanding of the possible interactions between health, nutrition, and noise exposure in producing noise-induced hearing loss; improved understanding of the possible effects of noise on susceptibility to disease.

This noise program has recently been initiated. Through interagency agreement in FY 74, interdisciplinary planning was initiated on the effects of noise on children. Specifically, the National Research Council/National Academy of Sciences Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) is reviewing existing information. NINDS will make the review document available to the general public. New research projects expected to be implemented in FY 75 are: animal studies of the effects of noise on young ears and a study of auditory responses, in noise and in quiet, of children ranging from the very young to age six. Planned for initiation in FY 75 is a detailed study of auditory sensitivity and discrimination among children (8-12 year age range) who have lived in noisy environments for a number of years and of children from quiet environments.

Another research project on noise-induced hearing loss will be initiated in FY 76 (in FY 75, if additional funds become available). This will involve a study of the economic and social impacts of noise-induced hearing loss and will investigate such areas as numbers of persons experiencing noise-induced hearing loss by type of employment activity, reduction in earning potential, reduction in retirement benefit potential, and change in patterns of activity outside the working environment.

Finally, a study of presbycusis and its relationship to noise exposure, circulatory factors, nutrition, etc., is scheduled to be planned in FY 77 and initiated in FY 78.

Table D-2

NINDS RESEARCH ON NOISE-INDUCED HEARING LOSS

Noise-Induced Hearing Loss Projects	Funding (Thousands of Dollars)		
Program: Communicative Disorders (Effects of Noise on People)	FY 73	FY 74	FY 75
1. Effects of Noise on Children	0	20	0
2. Experimental Studies of Effects of Noise on Young Ears (Primates)	0	0	340
3. Auditory Responses in Quiet and Noise Among Very Young Children	0	0	120
4. Auditory Sensitivity and Discrimination Among Children Living in Noisy Environments	0	0	120
5. Economic Impacts on Noise-Induced Hearing Loss[1]	0	0	0
6. Presbycusis[1]	0	0	0
Laboratory of Neuro-Otolaryngology			
(Being established)	0	28	15
Grants Program			
1. Susceptibility to Hearing Loss	45	47	49
2. Causes of Deafness	365	387	413
3. Auditory Communications and Its Disorders	461[2]	586[2]	598[2]
4. Noise Effects on Audiogram and Cochlea	37	0	0
TOTALS	447	482	1057

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[1] In planning phase

[2] Project funding covers work not noise-related and is not included in totals.

Laboratory of Otolaryngology - The objectives of this program include increased understanding of the auditory system in order to understand the full significance of noise-induced destruction of cochlear hair cells, to seek possible prevention of noise-induced hearing loss, and to seek methods of treating persons who have already experienced noise-induced hearing loss.

As this program is currently being established, no specific projects have been identified. However, the funds reported are noise-related only.

Grants Program - NINDS support of research on the effects of noise exposure has continued for a number of years through the extramural grant program. These studies, concerning both biologic effects of noise on the auditory system and human responses to noise, constitute a large portion of presently available data.

Several laboratories are presently conducting research on the basic mechanisms of destruction of the cochlea (or inner ear) resulting from exposure to noise. Procedures have been developed for using animals in this work since recordings are made of the electrical responses of cells and histological analyses of cellular tissue can be completed. This means that investigators have also needed to develop procedures for obtaining "hearing tests" from these animals so that the perceptual effects of noise damage could be studied together with the physiological effects. One grantee has demonstrated that levels and durations of noise which do not produce lasting impairment in behavioral response to pure tone (no lasting effect on the "hearing test") are nevertheless sufficient to produce considerable cellular damage to the cochlea. In addition to research on the physiological damage incurred to the hair (or receptor) cells of the cochlea, investigators are attempting to understand the exact process by which this happens. For example, it is not clear whether exclusively mechanical factors are involved in destroying the receptor cells or whether biochemical or bio-electrical factors must also be considered.

Another area under investigation is the relationship between temporary shift of the auditory threshold resulting from noise exposure and permanent noise-induced hearing loss. One investigator has anticipated that measurement of temporary threshold shift in human populations exposed to noise might warn of impending permanent hearing loss, but the usefulness of that diagnostic strategy is now being reconsidered.

1.2 Nonauditory Health Effects

NINDS is developing a new program concerned with the effects of noise on health. Initial emphasis, planned to begin in FY 76, will concern increased susceptibility to disease as a result of noise exposure. This new project will utilize all resources of the major NIH facility, located in Bethesda, Maryland. At the present, responsibility for planning this research rests with the Communicative Disorders program.

1.3 Communications Interference

Understanding and defining the impact of noise on human communication, with particular emphasis on speech communication, is a major NINDS objective. NINDS is concerned with the intelligibility of everyday speech for both normal listeners and for listeners with communicative disorders. For this latter population, NINDS also emphasizes the objective of ameliorating ability to understand speech in noisy environments.

Through its grants program NINDS has previously funded research on masking and speech interference. Initiated in FY 74, by contract, is research directed to the development of a new test for speech discrimination in noise. This work was undertaken in recognition of the limitations of pure tone tests of auditory sensitivity (i.e., audiograms) and of most existing "speech tests" which do not adequately measure the cognitive aspects of understanding speech. This project is developing an instrument for measuring discrimination in noise of connected speech containing key test words that vary in predictability and familiarity. Speech discrimination will be measured in the presence of a competing speech message at several signal-to-noise ratios and at least two widely different signal levels for groups of subjects with normal hearing, conductive hearing impairment, and acquired sensorineural hearing impairment.

A study of message transmission in noise is planned for initiation in FY 79.

Project funding levels for this effort are shown in Table D-3.

2. NIEHS

NIEHS has a major research effort in noise-induced hearing loss and also pursues work in nonauditory health effects.

The Noise Effects Program of the National Institute of Environmental Health Sciences is an integral facet of the Institute's concern with the effects of adverse environmental agents and energy mechanisms. The Noise Effects Program is designed to make maximum use of the Institute's multidisciplinary makeup to facilitate the study of the effects of this ubiquitous environmental insult.

The noise effects laboratory is located in the Environmental Biophysics Branch where personnel with research backgrounds in auditory and neurophysiology, acoustics and medicine form a core from which investigations have been and are being carried out, not only in traditional histopathological and electrophysiological effects of noise on the inner ear, but have extended into teratogenic effects and pharmacologic effects and into the underlying biochemical dysfunctions which precede hearing loss. Other nonauditory effects including endocrine and immuniological disorders are also being studied.

Table D-3

NINDS RESEARCH ON COMMUNICATION INTERFERENCE

Projects in Communications Interference	Funding Levels (Thousands of Dollars)		
Communicative Disorders Program (Effects of Noise on People)	FY 73	FY 74	FY 75
1. Development of Test Instrument for Assessing Speech Discrimination in Noise	0	140	100
2. Message Transmission in Noise (in planning phase)	0	0	0
Grants Program			
Noise-Induced Deafness: Masking and Speech Perception	79	0	0
TOTALS	79	140	100

Nearly all of the NIEHS work is done via research animals. Fortunately, the peripheral auditory systems of most mammals including man are very similar. Thus research animals can be confidently utilized for the study of the inner ear-sensorineural losses which are the characteristic effect of excessive noise insult.

Most hearing losses from noise are characterized by gradual deterioration from repeated exposures. A major part of the present on-going program is a continuing study of how these repeated exposures affect the ear's ability to recover and what biochemical and physiological disruptions hold the key to understanding the process.

The Institute's interdisciplinary capabilities have recently been focused on the study of synergisms between noise and other ototoxic agents, both intramurally and extramurally. Noise has been found to greatly potentiate the effect of the family of aminoglycoside antibiotics (neomycin, etc.). The mechanisms of this synergism is the subject of an investigation by one of our contractors. Other ototoxic agents studied include salicylic acid (aspirin) and certain heavy metals including lead and mercury.

2.1 Noise-Induced Hearing Loss

NIEHS has one program of studies, initiated about July 1972, on the effects of noise and other ototoxic agents on the auditory and nonauditory systems. Five specific projects in noise-induced hearing loss were in effect on this program in the FY 73-74 period. One additional project in noise-induced hearing loss was performed on a grant in FY 74 under the agency's extramural program. Program/project relationships and funding levels for this effort are shown in Table D-4.

Specific projects conducted in the FY 73-74 period on the NIEHS research program include:

- A comparative investigation of the hearing loss threshold curve for young and mature animals, being conducted in response to evidence indicating greater susceptibility of young cochlea to noise-induced physiological (tissues, muscles, cells, etc.) and pathological (disease) alterations. Firm recommendations regarding criteria for maximum noise exposures for prevention of noise-induced deafness in newborns cannot presently be made because of the paucity of data. It appears medically prudent to take extreme precaution to avoid exposing newborns to excessive noise.

- A study of the combined effects of noise and salicylates (such as aspirin) on cochlear morphology and the auditory threshold. Studies thus far indicate

Table D-4

NIEHS RESEARCH ON NOISE-INDUCED HEARING LOSS

Noise-Induced Hearing Loss Projects	Funding Level (Thousands of Dollars)		
Program: Effects of Noise and Other Ototoxic Agents on the Auditory and Nonauditory Systems	FY 73	FY 74	FY 75
1. Investigation of Hearing Loss Threshold Curve for Young vs. Mature Animals	25	25	0
2. Combined Effect of Noise and Salicylates on Cochlear Morphology and Auditory Threshold	20	0	0
3. Identification of Physiological Dysfunction in Neurosensory Hearing Loss Induced by Ototoxic Agents	0	8	29
4. Physiological Study of Auditory Fatigue (Induced by Noise)	0	8	26
5. Interaction of Noise and Ototoxic Drugs on Hearing Loss in Animals	100	100	100
Extramural Program			
1. Combined Impulse-Continuous Noise: Auditory Effect	0	51	44
TOTALS	145	192	199

that a profound ototoxic interaction is not taking place, though a clinically significant interaction is a distinct possibility.

- A study of the changes in energy utilization and production under the influence of known ototoxic agents (e.g., noise, ethacrynic acid, etc.) by utilizing electrophysiological*, biochemical, and radioactive tracer techniques and to pinpoint the specific mechanism by which these actions occur in the cochlea.
- A study of auditory fatigue in which the loci or nature of the physiological changes underlying the temporary or permanent threshold shift are being investigated, as well as the potential of auditory fatigue by subtoxic doses of antibiotics.
- A study to determine the nature of the interaction between noise and ototoxic drugs in experimental animals, and to investigate the biochemical mechanisms involved in such losses.

The following project was conducted by a grantee on the NIEHS extramural program:

- A study of the effects of combined impulse and continuous noise on hearing sensitivity and cochlear anatomy. The extent of noise-induced trauma from these combined sources cannot be explained by addition of the acoustic power of the sources. These data are a necessary prerequisite for the ultimate establishment of damage risk criteria for impulse-continuous noise combinations.

2.2 Nonauditory Health Effects

NIEHS has one current program with five specific projects on nonauditory health effects research. Programs, projects, and funding for this research are shown in Table D-5.

One of the objectives of this NIEHS program is to investigate, through animal models, specific physiologic mechanisms** which may be effected by chronic noise exposure.

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*Electrical techniques for measuring responses

**Including endocrine (glandular) immunologic, pharmacologic (drug), teratogenic (spontaneous birth malformation), cardiovascular (heart and circulatory), and others.

Table D-3

NIEHS RESEARCH IN NONAUDITORY HEALTH EFFECTS

Nonauditory Health Effects Research Projects	Funding Level (Thousands of Dollars)		
Program: Effects of Noise and Other Ototoxic Agents on the Auditory and Nonauditory Systems	FY 73	FY 74	FY 75
1. Teratogenic Effects of Noise Exposure and Deprivation	0	10	8
2. Effects of Noise on Corticosterone Secretion in the Rat	0	16	0
3. Noise Polymorphonuclear Leukocyte Function	0	12	8
4. Noise and Cellmediated Immunity	0	28	24
5. Noise in the Hospital	8	0	0
TOTALS	8	66	40

Under this program, NIEHS is concerned with the investigation, through studies on research animals, of effects of noise and noise-drug interaction on physiological systems and processes other than the auditory systems. NIEHS pursued work on noise effects on the cardiovascular and neural functions in animals which is directed toward determining the exact noise levels at which effects occur, the progress of effects with time, and the ultimate extent of functional impairment. Other systems and processes of interest in current research include:

- A study of the effects of continuous and intermittent noises on adrenal corticoid secretion and of the long-term effects after cessation of noise. Experimentation is being conducted with rats.

- Direct study of the effects of noise of differing duration, both constant and intermittent, on leukocyte (white blood cell) functions such as locating and destroying bacteria and viruses.

- An effort to replicate work of foreign scientists which has shown various immunological deficiencies after chronic noise exposure in experimental animals and in human workers.

- Research to determine whether background noise levels in gestating animal quarters have any role in producing spontaneous birth malformations and to assess these teratogenic effects of increased noise stimuli from a controlled source.

FY 73 NIEHS work on noise in hospitals has been published in the professional literature. Results included data on noise levels found in various types of rooms as a function of occupancy and the relationships between these levels and nonauditory health effects on the hospitalized patient.

3. NIOSH

NIOSH has a major research effort on noise-induced hearing loss and also does research in three other categories: nonauditory health effects, individual behavior effects, and measurements methodology and calibration.

3.1 Noise-Induced Hearing Loss

NIOSH involvement in noise-induced hearing loss stems from the Occupational Safety and Health Act of 1970 (Public Law 91-596) and the Federal Coal Mine Safety and Health Act of 1969 (Public Law 91-973) which charge the agency with undertaking research and related activities basic to assuring safe and healthful workplace conditions. Research directives under this authority emphasize criteria development efforts for furnishing new health and safety standards and acknowledge needs for more effective techniques of hazard control. The NIOSH effort is in accordance with the goal of identifying and characterizing adverse effects of occupational noise exposures for purposes of defining health and safety requirements for setting noise standards at the workplace.

NIOSH has two general research activities in noise-induced hearing loss under which eleven specific research efforts are currently being pursued. Projects and funding levels for these are shown in Table D-6. From 50 to 60% of NIOSH noise research manpower is given to these two general activities with in-house studies being supplemented by grants, contracts and special foreign currency research agreements (Public Law 480).

Items in parentheses in the following tables reflect best estimates of NIOSH funding in FY 73, but may have been drawn from projects whose titles differed slightly from those listed in the tables. Furthermore, there may be some FY 73 funding which was missed in compiling these data because it was funded under projects terminating in FY 73.

Occupational Hearing Loss - NIOSH has conducted numerous field surveys to interrelate noise conditions in various industries, years of exposure to such noise and the incidence and magnitude of hearing loss in working groups. These data, together with that gained from controlled laboratory studies of hearing changes caused by specific exposure variables, became a part of the basis for a NIOSH criteria document and a suggested new occupational noise standard for safeguarding hearing. This recommended standard is currently under review by the Department of Labor.

The applicability of the proposed standard for coal mining is also being considered in light of the results of a joint NIOSH-Bureau of Mines survey of noise and hearing loss in coal miners.

Special efforts currently being pursued on this program include the following:

- Epidemiological studies of hearing loss due to occupational noise, analysis of existent data on the subject, and field studies for development of hearing risk criteria. This emphasizes intermittent, fluctuating, and impact noise and exposures greater than eight hours per day.

- Development of a coal mine audiogram data bank and analysis of data from a hearing and noise survey of coal miners. This work is aimed toward development of coal mine noise standards.

- Epidemiological study of noise-induced hearing loss and vibration disease among workers using powered saws, being pursued on a foreign currency agreement with Poland.

Table D-6

NIOSH RESEARCH ON NOISE-INDUCED HEARING LOSS

Specific Noise-Induced Hearing Loss Efforts[1]	Funding (Thousands of Dollars)		
General Research Activities:[1] Epidemiological Studies, Data Evaluation and Development of Health Criteria	FY 73	FY 74	FY 75
1. Evaluation of Hearing Risk Due to Industrial Noise	(75)[5]	79	104
2. Short-Term Physical Agents Research: Coal Mine Noise	(35)[5]	10	0
3. Effects of Noise and Vibration on Health of Woodcutters[2]	--	--	--
4. Exposure to Noise in the Cotton and Flax or Textile Industry[3]	--	--	--
5. Noise and Hearing in the Paperworking Industry	0	0	41
General Research Activities:[1] Experimental Studies of the Effects of Occupational Noise on Hearing			
1. Laboratory Studies of Noise-Induced Hearing Loss	0	87	91
2. Combined Effects of Noise, Work, and Heat on Human Hearing	(24)[5]	18	0
3. Aspects of Ear Tolerance to Noise	50	0	0
4. Laboratory and Field Study of Impact Noise	40	0	To be determined
5. Damage Risk Criteria for Intermittent Noise Exposure	0	56	47
6. Noise and Heat Effects on Man[4]	--	--	--
7. Effects of Impulse Noises on the Auditory System	0	91	69
TOTALS	224	341	352

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[1] NIOSH does not use the terms "program" and "project" in the same sense as this report. Thus the use of those terms has been avoided.

[2] Total funding of $212,600 for the period 7/68 to 9/74

[3] Total funding of $ 99,400 for the period 7/71 to 7/75

[4] Total funding of $167,000 for the period 5/72 to 4/77

[5] Project titles were not the same in FY 73.

- Epidemiological study of noise levels and hearing acuity of exposed workers to develop safe-level criteria for long-term exposure to steady noise. This project is being conducted on a foreign currency agreement with Egypt.

Experimental Studies of Occupational Noise Effects on Hearing - Research in this problem area for FY 73, continuing through FY 74,and planned for FY 75 is attempting to supply evidence confirming the need for and nature of different exposure limits to take account of certain noise conditions commonly found in industry, e.g., repeated impact sounds as opposed to steady-state sounds, intermittent or variable exposures as distinct from continuous or constant exposures, and work-shift noise exposures lasting longer than eight hours per day.

Other related work expected to end in FY 74 or early FY 75 involves identification of (1) added heat and workload effects on noise-induced threshold shifts, (2) factors underlying increased ear resistance to noise-induced hearing change, and (3) hearing loss and other potential hazards from industrial equipment emitting ultrasonic energy.

Specific research efforts conducted in FY 73-74 include:

- Laboratory studies of occupational noise effects including temporary and permanent hearing loss and anatomical damage to the inner ear. The work emphasizes impact noise, fluctuating noise and methods of measuring hearing loss. Both animal and human subject research are involved. This project includes both in-house and contract effort.

- Evaluation of physiological, audiological, and otological data obtained from selected groups of industrial workers to identify particular factors which differentiate susceptible from nonsusceptible workers in terms of their tolerance to noise exposure.

- Laboratory tests of human subjects and measurement of industrial noise exposures to obtain data to aid in developing criteria for a health standard on impact noise.

- Laboratory studies of temporary hearing threshold shift from intermittent noise exposures in order to evaluate and develop damage risk criteria for occupational exposures.

- A study to determine the health consequences to workers exposed to both heat and noise at the work site and establish under controlled laboratory conditions the auditory and circulatory interactions elicited by noise and heat exposure. This work is being performed on a foreign currency agreement with Poland.

- Studies of changes in anatomy and physiology of the inner ear, as well as temporary hearing loss, due to exposure to impulse or impact noise at high levels. This work involves animal test subjects.

3.2 Nonauditory Health Effects

NIOSH has one current general research activity with the three specific research efforts in nonauditory health effects. The goals are to determine whether adherence to occupational noise limits for safeguarding hearing can also minimize problems of performance errors or accidents, stress-related ailments, and sick-absenteeism also reputed to be caused by high workplace noise levels.

Funding levels for the agency's research in nonauditory health effects are shown in Table D-7.

The following specific research efforts are being pursued under the agency's program on extra-auditory effects of occupational noise:

- A study of worker safety and health in which a comparison is made of entries in the medical, attendance, and safety records of workers in noisy jobs before and after the advent of a company hearing conservation program.

- Laboratory studies to examine the effects of noise exposure at maximum permissible occupational levels upon visual, tactile, thermal, vestibular, and kinesthetic sensory functions.

3.3 Individual Behavior Effects

NIOSH is concerned with the behavorial response of workers to noise, particularly as it may lead to performance error and accidents.

Funding levels for research in individual behavior effects are shown in Table D-8. These represent NIOSH-sponsored grants.

Table D-7

NIOSH RESEARCH IN NONAUDITORY HEALTH EFFECTS

Specific Nonauditory Health Effects Research Efforts[1]	Funding Level (Thousands of Dollars)		
General Activity: Extra-Auditory Effects of Occupational Noise	FY 73	FY 74	FY 75
1. Effects of a Company Hearing Conservation Program on Noise-Related Extra-Auditory Disturbances in Workers	0	42	0
2. Effects of Noise on Nonauditory Sensory Functions and Performance	78	0	21
3. Effects of Noise and Heat and Health of Workers in Metal Industry (PL-480 Research Agreement)	30	0	0
TOTALS	108	42	21

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[1] NIOSH does not use the terms "program" and "project" in the same sense as this report. Thus their use has been avoided.

Table D-8

NIOSH RESEARCH ON INDIVIDUAL BEHAVIOR EFFECTS

Specific Individual Behavior Effects Efforts[1]	Funding Level (Thousands of Dollars)		
General Activity: Extra-Auditory Effects of Occupational Noise[2]	FY 73	FY 74	FY 75
1. Effects of Three Sound Environments on Human Behavior	0	8	0
2. Noise and Human Performance	0	20	0
TOTALS	0	28	0

---

[1] NIOSH does not use the terms "program" and "project" in the same sense as this report. Thus their use has been avoided.
[2] This NIOSH activity also includes research efforts categorized as nonauditory health effects in this report.

The following grant research projects are just complete or continuing:

- A study of the effects of three sound environments on human behavior, designed to identify the various conditions of a noise stimuli on performance in a realistic work situation. This study was initiated in recognition of the fact that: noise-induced performance effects are specific to the tasks used, and, that work requirements and work schedules of most noise-related research projects have little resemblance to actual work conditions.

- A study of noise and human performance, primarily concerned with the relationship between the meaning which may be associated with particular sounds or noise and the effects of these sounds on human performance. Through various techniques, including conditioning, meaning will be attached to particular sounds. The effects of these sounds on various types of performance tasks, which have a number of built-in subsidiary tasks, will be determined.

Starting in FY 76, NIOSH is planning a new study of worker accidents and near-accidents in noisy job settings relative to implicating noise as a contributing causal factor.

3.4 Measurement Methodology and Calibration

NIOSH conducts research to improve instrumentation, test systems and survey methodologies to support research in industrial hearing conservation and occupational noise control and to improve acoustic measurement techniques in general. The agency has two research projects in measurement methodology and calibration. Funding level for this effort are shown in Table D-9.

The following specific research efforts are underway:

- Work on the NIOSH audiometric measurement activity includes the study of alternative methods of measuring occupational hearing loss, construction of a programmable electro-acoustic test system, and investigation of methods for automatic processing of audiometric data.

- The agency's current project on improved methods for occupational noise survey includes: laboratory and field tests on noise dosimeters, development of improved methods for their usage, and development of performance tests for use in the NIOSH certification program.

Table D-9

NIOSH RESEARCH IN MEASUREMENT METHODOLOGY AND CALIBRATION

Specific Measurement Methodology and Calibration Efforts[1]	Funding Level (Thousands of Dollars)		
General Activity: Industrial Hearing Conservation Practices, Acoustic Measurements, and Occupational Noise Control	FY 73	FY 74	FY 75
1. Industrial Audiometric, Hearing Conservation Technology and Noise Control	(31)[2]	52	80
2. Measurement of Occupational Noise	(32)[2]	44	28
TOTALS	63	96	108

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[1] NIOSH does not use the terms "program" and "project" in the same sense as this report. Thus their use has been avoided.

[2] The project titles were not the same in FY 73.

4. DOD

DOD pursues current major research efforts in the following categories:

- Noise-induced hearing loss
- Individual behavior effects
- Communication interference
- Measurement methodology and calibration.

DOD also conducts current research efforts in the following categories:

- Nonauditory health effects
- Community or collective response.

4.1 Noise-Induced Hearing Loss

Military agencies of DOD are involved in research on noise-induced hearing loss by personnel in a wide variety of environments, including:

- Firing of weapons
- Aeronautical operations
- Shipboard compartments.

The overall goal of this research is the conservation of hearing of personnel by setting and adhering to exposure criteria where possible and providing protective devices in other cases.

The Army, Navy, and Air Force each have research programs in noise-induced hearing loss with a total of thirteen specific projects. These are listed together with project funding levels in Table D-10.

U.S. Army Program - The goals of the Army program in noise-induced hearing loss are to identify the causes and relationships between hearing loss and exposure to noise in the environments of the various army branches and to determine how to protect the hearing of Army personnel.

The Army prepared three technical reports in FY 73 on its work on the relationship of hearing change to acoustic inputs which present findings which seriously question existing theories of auditory damage risk and could result in significant changes in theory if verified.

The following specific projects are being pursued under the Army program of research in noise-induced hearing loss:

Table D-10

DOD RESEARCH IN NOISE-INDUCED HEARING LOSS

Noise-Induced Hearing Loss Projects	Funding Level (Thousands of Dollars)		
U.S. Army Program	FY 73	FY 74	FY 75*
1. Military Performance-Traumatic Origins of Hearing Loss	0	0	
2. Relationship of Hearing Change to Acoustic Inputs	62	66	
3. Prevalence of Hearing Loss Within Selected U.S. Army Branches	0	20	
4. Hearing Conservation: Intense Acoustic Stimulation and Noise Susceptibility in the Military Environment	46	0	
U.S. Navy Program			
1. Communications: Hearing of Naval Personnel as a Function of Noise Exposure	20	0	
2. Study of Anatomic Changes in the Middle Ear Associated with Noise-Induced Hearing Loss and Acoustic Trauma	10	19	
3. Middle Ear Compliance and Its Relationship to Military-Related Noise-Induced Hearing Loss and Acoustic Trauma	8	13	
4. The Incidence of Hearing Loss Among Various Navy Rated Personnel	0	50	
5. Development of Damage Risk Criteria and Habitability Standards for Exposure to Sonar Transmissions	20	25	
U.S. Air Force Program.			
1. Effects of Noise on Air Force Personnel in Operational Environments	20	49	
2. Research on Permanent and Temporary Shifts in Hearing Thresholds Produced by Exposure to Air Force Noise	0	2	
3. Auditory Responses to Acoustic Energy Experienced in Air Force Activities	24	22	
4. Human Subjects for Operating Acoustic Research	38	35	
TOTALS	248	301	301*

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*DOD FY 75 data estimated the same as FY 74.

- Analysis of causes of hearing loss, beginning with the cochlea and proceeding to higher levels of the nervous system. Changes in sensitivity are followed as animal ears are exposed to high intensity pure tones and impulses, followed by histology.

- Investigation of the prevalence of hearing loss in selected Army branches (infantry, artillery, and armor) and its relationship to the length of time in the service.

- A study of premature hearing loss by Army troops. This work includes an evaluation of current noise sources and the effectiveness of protective devices and current hearing conservation practices in the field.

U.S. Navy Program - The U.S. Navy program of research in noise-induced hearing loss is directed to development of increased knowledge of the mechanisms of anatomic change involved, to define the incidence of noise-induced hearing loss in Navy job specialties, and to develop hearing conservation standards for specific job specialties. The following specific projects are being pursued under the Navy program:

- A study of anatomic changes in the middle ear associated with noise-induced hearing loss and acoustic trauma. Histologic examinations of temporal bones from autopsies are evaluated for changes in the auditory nerve and organ of corti, results of which are then correlated with the background of noise exposure and acoustic trauma as well as with clinical findings including the audiogram.

- A study correlating middle ear compliance audiograms and noise exposure histories designed to provide new and productive data regarding susceptibility to noise-induced hearing loss in military personnel.

- A study of the incidence of noise-induced hearing loss among Navy personnel working in various Navy rated job specialties.

U.S. Air Force Program - The Air Force research program is directed toward defining risks of noise-induced hearing loss in Air Force environments and for developing regulations and guidelines for hearing conservation.

The Air Force prepared a comprehensive document for establishment of criteria for limiting noise levels to protect hearing of personnel and a review document on infrasound and hearing.

Research on effects of noise on Air Force personnel has resulted in auditory damage risk criteria published in AFR 161-35 titled Hazardous Noise Exposure. It was found that all categories of Air Force aircraft studied contained definite degrees of auditory risk to unprotected ears according to the newly adopted auditory risk limits.

Air Force research on temporary threshold shift for 16-hour exposures has been submitted for publication in the professional literature. Subjects tested showed varying response including some with an asymptote-type response after eight hours, some with a continued sharp rise of TTS for the entire 16 hours and a few with asymptotic effects after one-hour exposure. Data have not been fruitful in predicting noise-induced permanent threshold shift. It was being considered that the magnitude of asymptotic levels of TTS or the rate at which the asymptote is approached may be an appropriate predictor for noise-induced hearing loss.

The following specific projects are being pursued under the Air Force program:

- A study of the hearing status of Air Force personnel in the operational environment and development of special tests for selection and continuance of personnel in career fields involving noisy environments.

- Research on permanent and temporary shifts in hearing threshold produced by exposure to Air Force environments.

- An investigation of hearing loss, personal sound protective devices, infrasonic and impulsive signals, and related subjects. The work is directed toward development of regulations and guidelines for risk to hearing.

4.2 Nonauditory Health Effects

The Air Force had a single research project in FY 73 on the effects of acoustical energy on vestibular functioning. Goals of this research were to develop an understanding of the conditions and manner in which high intensity noise effects the equilibrium and produces disorientation and to contribute to the development of threshold criteria for hazardous exposure to high intensity sound.

A review paper on Air Force research on the effects of infrasound on the vestibular system was prepared on this project.

Funding level on this project was $10,000 in FY 73.

4.3 Individual Behavior Effects

This agency's research efforts are directed toward defining and analyzing the effects of exposure on personnel, evaluating and optimizing the performance under the exposures encountered in the military services and evaluating protective devices for mitigating response to noise. The Army, Navy, and Air Force each have research programs in this category. The current Air Force program includes research of a more fundamental nature.

Six specific research projects were underway in the FY 73-74 period, for which funding levels are shown in Table D-12.

The following specific project activity was pursued:

U.S. Army - The army project is directed toward developing predictive models of noise effects on soldiers' performance and improving existing noise criteria, including effects of long-term exposure. A new Army Materiel Command noise standard was published and the first Army-wide military standard on noise limits was fully coordinated and published.

U.S. Navy - Current Navy research on individual behavior effects of noise is directed toward evaluating and optimizing human performance under exposure to noise in submarine and aircraft environments.

Laboratory evaluations have been conducted on headsets proposed for use by acoustic sensor operators in antisubmarine warfare patrol and on military noise cancelling microphones. Experiments have been conducted on the effects of high noise levels on sonar doppler and on auditory tracking of a signal under perceptual arrangements. The following two specific projects are currently in progress:

- In its work on auditory performance in submarines, the Navy is studying the physical characteristics of sound systems and the performance of operators. This includes work on hearing sensitivity and auditory vigilance by behavioral and electrophysiological means under various conditions of complex auditory displays. Parameters in target detection are to be specified and their quantitative effect on target detection determined.

- The second project is directed to optimizing auditory performance in naval acoustical environments and minimizing problems arising from the many forms of sound/man interaction, including auditory fatigue due to prolonged exposure to flight operation noises. New tests and procedures are being developed and evaluated to assess man's ability to perform auditory tasks and otherwise enable individuals to operate efficiently in naval aviation acoustical environments.

U.S. Air Force - Air Force concerns regarding individual behavior effects cover a wide range of intense noise environments affecting motor

Table D-11

DOD RESEARCH ON INDIVIDUAL BEHAVIOR EFFECTS

Projects on Individual Behavior Effects	Funding Level (Thousands of Dollars) FY 73	FY 74	FY 75
U.S. Army Program			
1. Improved Weapon Noise Exposure Criteria	62	66	
U.S. Navy Program			
1. Optimization of Performance in Submarine	54	44	
2. Optimization of Auditory Performance in Naval Aviation	40	35	
U.S. Air Force Program			
1. Simultaneous Exposure to Acoustic Energy and Other Stressors Found in Air Force Environments	7	3	
2. Whole Body Effects of Air Force Noise on People	24	18	
3. Research on Intermittent Noise Effects on Air Force Target Detection Tasks	46	0	
TOTALS	233	166	166*

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*FY 75 data estimated the same as FY 74

performance, vestibular functioning, physiological functioning, thought processes, and the contribution to apprehension and fatigue of personnel.

Eight years of in-house research on whole body effects of Air Force noise environments on people were published in Air Force reports and summarized in a paper published in the Proceedings of the International Congress on Noise as a Public Health Problem sponsored by EPA. A study of human performance effects of impulsive noise, randomly varied with respect to intensity, duration and time of occurence, has been prepared.

The following specific projects are currently under underway:

- A research study on simultaneous exposure to acoustic energy and other stresses found in Air Force environments which combines controlled acoustic exposures with mechanical whole body vibration of volunteers to determine effects of the combined exposures on psychomotor task performance, mental or cognitive performance, temporary threshold shift, and possible subjective judgments of acceptability. Single stress effects are being compared to the measured multiple stress effects to determine differential contributions of the respective stress conditions.

- A study of whole body effects of Air Force noise on people that involves investigation of numerous types of noises and exposure conditions in which accomplishment of the Air Force mission may be threatened. The approach is to measure the effects of the many kinds of noise (infrasound, audio frequencies, impulses) on standard and special performance tasks, circulation in the peripheral members, on physiological processes, on mental tasks such as memory, and on various measures of vestibular functioning such as equilibrium, counterrolling of the eyes and nystagmus. Findings are used to establish exposure limits beyond which undesirable effects may occur. Much of this work is possible only because of the unique stimulus generators available at the Aerospace Medical Research Laboratory.

4.4 Communication Interference

DOD research in communication interference is directed toward enhancing or optimizing intelligibility of speech and signals in military acoustical environments. Current interests are in air/ground and ground/air communications and personnel communications in submarine and shipboard jobs requiring high levels of auditory acuity. Another goal of DOD research in communication interference is to reevaluate criteria and validate audiometric standards for Navy ships.

The Navy and Air Force have current program activity related to communication interference and the Army has also done prior work in this category. Funding levels for DOD research in this category are shown in Table D-12.

The following specific projects are being pursued on the current DOD programs:

- Work on optimization of speech communication in naval aviation involves development and evaluation of new tests and procedures to assessing the ability of aircrewmen to communicate in various naval aviation acoustical environments and the capability of air-to-ground and ground-to-air communicating systems to transmit intelligible speech. Investigations to date indicate that preferred listening levels for speech of aviators and aircrew personnel probably represent speech levels where maximum intelligibility can be achieved. Preferred signal-to-noise ratios have been identified for certain noise levels.

- A second Navy project is directed toward development of auditory screening and acoustical tolerance standards for submarine and shipboard personnel. Experimental studies are being conducted to assess auditory perception of a variety of speech materials and signal stimuli, embedded in various background sound fields, for personnel of differing levels of acuity. Longitudinal studies are conducted to assess changes in hearing abilities among submarine personnel to identify predictive indices of hearing loss and the habituation process which enhances operator auditory acuity. The latter is of potential benefit in the design of training programs, auditory aids, or acoustical characteristics of submarine environment.

Data were collected to evaluate the proficiency of several different speech reception tests. Four new tests of speech in noise and in quiet have been constructed. Results of this work are published in a series of reports.

- The current Air Force project involves investigation of the response of human subjects to pure tones, speech and noise. Evaluations are being made of new techniques and instruments for measuring the auditory function of flying personnel with or without hearing impairment. Simulated inflight hearing tests are involved.

4.5 Community or Collective Response

Within DOD the Air Force had, in the past, a very considerable involvement in research on community or collective response. However, the USAF had

Table D-12

DOD RESEARCH IN COMMUNICATION INTERFERENCE

Projects in Communication Interference	Funding Levels (Thousands of Dollars)		
U.S. Navy Program	FY 73	FY 74	FY 75*
1. Optimization of Speech Communication in Naval Aviation	40	40	
2. Development of Auditory Screening and Acoustical Tolerance Standards for Submarine/Shipboard Personnel	30	33	
3. Sound Conduction in the Ear Affecting Military Communications	26	0	
U.S. Air Force Program			
1. Assessment of Hearing in Flying Personnel	28	36	
TOTALS	124	109	109*

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*FY 75 data estimated the same as FY 74

only a single project, Effects of Air Force Noises on Populations Surrounding Air Bases, active in FY 73 at a funding level of $31,600.

4.6 Measurement Methodology and Calibration

The Army, Navy and Air Force each have research programs in measurement methodology. Objectives of this work are to provide specialized support of noise health effects research through development and upgrading of measurement systems, procedures, equipment, and facilities. Activities pursued on these programs include:

- Development of new measurement methodology and test procedures and criteria
- Evaluation/validation of measurement procedures
- Instrumentation development
- Development of conceptual computational procedures and major computer software
- Developing procedures for assessing/predicting effects
- Establishing and operating environmental noise data banks
- Developing instrument calibration techniques and equipment.
- Developing equipment and procedures for evaluating human response.

Seven current research projects are underway. Program/project relations and funding levels for this effort are shown in Table D-13.

The following seven specific projects were underway in the FY 73-74 period:

U.S. Army Program

- The Army's research on psychoacoustic problems in aviation included development of a new measurement methodology and quality control test for real-ear sound attenuation characteristics of helmets and a test for an advanced voice communication system. A new helmet for tank crewmen was tested and accepted as a standard.

Table D-13

DOD RESEARCH IN MEASUREMENT METHODOLOGY AND CALIBRATION

Projects in Measurement Methodology and Calibration	Funding Levels (Thousands of Dollars)		
U.S. Army Program	FY 73	FY 74	FY 75*
1. Research in Psychoacoustical Problems Medically Significant to Army Aviation . .	85	195	
U.S. Navy Program			
1. Airborne Noise Criteria for Ships and Submarines	69	74	
U.S. Air Force Program			
1. Mechanics of Noise Generation, Propagation and Reception as Related to Air Force Bioacoustic Problems	3	2	
2. Bioacoustic Environments of USAF Aerospace Systems	92	68	
3. Bioenvironmental Noise/Research Program	43	0	
4. Development and Updating of Air Force Land Use Planning Procedure with Respect to Aircraft Noise	32	0	
5. Measurement and Analysis of Aircraft Noise Environments for Developing New Air Force Procedures to Forecast Noise Exposure . .	13	15	
TOTALS	337	354	354*

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*FY 75 data estimated the same as FY 74

U.S. Navy Program

- The Navy's research on noise criteria for ships and submarines emphasizes the establishment of measurement methods and criteria for limiting airborne noise in ship spaces and enforceable specifications for acceptable noise by equipments produced for use on naval vessels. Work included obtaining and comparing measurements of airborne noise in various ship compartments with measures of performance and habitability, and the evaluation/validation of the adequacy of measurement procedures under actual shipboard conditions, in the laboratory, in the field, and in equipment contractor plants.

U.S. Air Force Program

- A bioenvironmental noise research project to provide technical procedures, data and software required to define the high-level noise environments generated by Air Force weapons systems, determine the effect on man, and provide such information to user groups.

  This involved establishment and operation of a data bank for storing and retrieving bioenvironmental noise data and developing extensive major software to process and extrapolate measured environmental noise data.

  A wide variety of environmental and laboratory test stimuli were also measured and analyzed, including air bag transients, aircraft engine noise, and speech samples. Equipment and procedures were developed for evaluating effects of noise and performance.

  Special techniques and equipment were developed to calibrate various types of acoustic instrumentation.

- A project on mechanisms of noise generation, propagation and reception to provide engineering methods necessary to compute high noise level environments (e.g., ground runup). This work was undertaken to improve the algorithms used to predict far-field noise levels for application in both the Bioenvironmental Data Handbook and the noise exposure forecast program.

- A study of bioacoustic environments of aerospace systems in which noise environments are measured, analyzed and simulated by means of precision analog and digital instrumentation.

A very small noise recording system, called Micropak, was developed to be worn by pilots for obtaining noise data where space limitations are severe. A unique pistonphone was developed for calibrating microphones at infrasonic frequencies.

- The measurement of noise from numerous types of military aircraft and analysis and processing for use in calculating noise exposure forecasts. This work was undertaken to improve the accuracy and reliability of noise exposure forecast computations based on data files which had contained only estimated data on many aircraft systems.
- A project to develop a fully computerized computational methodology to automatically plot contours of equal exposure levels about an air base.

5. NASA

NASA conducts current major research efforts in three categories, noise effects on sleep, community or collective response, and measurement methodology.

5.1 Noise Effects on Sleep

The objective of NASA research in this category is to understand the relationship between aircraft noise exposure and sleep interference. The agency's work in this area is part of an ongoing research program on human response to noise which includes projects devoted largely to aircraft noise effects on sleep as well as other major projects in community and collective response and measurement methodology.

NASA's project on the human response to the aeronautical environment is directed toward understanding the psychophysiological effects of aircraft noise on people and to develop a quantitative understanding of individual response to noise exposure. This includes assessment of subjective reactions and effects on sleep, effects on hearing, and development of research evaluation techniques and measuring scales. Emphasis is placed on laboratory studies with complementary studies in communities exposed to noise and with special overflight programs where selected juries are exposed to noise. Studies are concerned with responses of people during both awake and sleep periods and under background noise conditions associated with outdoor, indoor and inflight situations.

Laboratory studies to evaluate noise effects on sleep are supplemented by initial studies of sleep responses of people living in communities exposed to commercial flight operation noise. Studies are being conducted in contractors' laboratories to evaluate both awakening and nonawakening effects of noise on sleep.

Funding levels for this effort are shown in Table D-14.

Table D-14

NASA RESEARCH ON NOISE EFFECTS ON SLEEP

Project in Noise Effects on Sleep	Funding Levels (Thousands of Dollars)		
Program: Human Response* to Noise	FY 73	FY 74	FY 75
Human response to the Aeronautical Environment	217	254	142
TOTALS	217	254	142

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*Total program includes work in community or collective response and measurements.

Table D-15

NASA RESEARCH IN COMMUNITY OR COLLECTIVE RESPONSE

Projects in Community or Collective Response	Funding Levels (Thousands of Dollars)		
Program: Human Response to Noise	FY 73	FY 74	FY 75
1. Acceptance of Aircraft Operations - Technology Assessment	173	172	232
2. Acceptance of Aircraft Operations - Community Noise	205	319	422
TOTALS	378	491	654

5.2 Community or Collective Response and Measurements

NASA research is conducted under its Human Response to Noise program whose overall goal is to develop an understanding of the relationship between aircraft noise exposure and annoyance, e.g., to define and quantify those properties of aircraft noise exposure that cause negative individual and community response to air transportation systems.

Specific targets set for the NASA program are:

- Devising proper methodologies for laboratory and field studies of human response to aircraft operations. FY 1975.
- Determining effects of multievent noise exposure characteristics on human response to aircraft operations. FY 1975.
- Quantifying the effects of background environmental noise exposure on the human response to aircraft-generated noise. FY 1975.
- Studying the effects of low frequency noise characteristics generated by present and future aircraft on auditory and nonauditory responses of people. FY 1979.
- Developing a model for reliable prediction of responses of people to aircraft operations that will satisfy laboratory and field conditions. FY 1980.

The NASA program includes two specific projects in community-collective response plus project work in other categories. Program/project relationships and funding levels for NASA research in this category are shown in Table D-15 on page 34.

The following specific projects are currently underway:

- NASA has a technology assessment project for developing an understanding of the social effects of large-scale air transportation systems and to design technology leading to improved safety and comfort of aircraft crew and passengers. This project includes in-house studies of the human response to aircraft sound stimuli. Human test subjects will be asked to give category judgment of aircraft sounds, including STOL signatures.

- NASA also has a current community noise study which includes evaluation of: noise characteristics of advanced VTOL and STOL aircraft; acoustic retrofit systems for CTOL aircraft; and noise alleviation procedures for aircraft and airport operations. This work will provide criteria for prediction of community acceptance of aircraft operations/community noise. Emphasis will be placed on laboratory studies and airport-community studies/surveys which may be supplemented by programmed overflight studies. These studies will be closely interrelated with, or in support of, NASA project activities (STOL) and with the DOT/FAA programs to control aircraft and airport noise. The laboratory techniques employed range from listening room testing with trained subject, to real-life situations where test environments represent the airport-community/home and where the test subjects may be people plagued by aircraft noise. These efforts efforts are summarized in Table D-16

Table D-16

NASA RESEARCH IN MEASUREMENTS

Project in Measurement Methodology and Calibration	Funding Level (Thousands of Dollars)		
Program: Human Response to Noise	FY 73	FY 74	FY 75
Acceptance of Aircraft Operations (Characterization of V/STOL Noise)	532	409	404

6. DOT

DOT has had recent research efforts in two categories, individual behavior effects and community or collective response.

6.1 Individual Behavior Effects

DOT had no project work under way in this category in FY 74. A program on startle effects of sonic boom was underway in FAA in FY 73, consisting of two specific projects. The U.S. Coast Guard also had foghorn aversiveness under investigation at NBS in FY 73. Funding levels for these projects are shown in Table D-17.

Table D-17

DOT RESEARCH ON INDIVIDUAL BEHAVIOR EFFECTS

Projects on Individual Behavior Effects	Funding Levels (Thousands of Dollars)		
	FY 73	FY 74	FY 75
1. Field Study of Sonic Boom Startle Effects	18	0	0
2. Determinants of Startle Response to Simulated Sonic Booms	27	0	0
Foghorn Aversiveness Study	5	0	0
TOTALS	50	0	0

6.2 Community or Collective Response

DOT research in this category is concerned with providing a valid measure of effectiveness for assessing relative benefits of alternative means for reducing transportation-related noises. DOT is concerned with all modes of transportation in this regard.

DOT has had a considerable program involvement in this area in the past. The agency's program now consists of one current project in the category which is scheduled for completion in June 1975. This consists of testing the feasibility of a technique developed on the project to assess the relative importance of various noises to the public, particularly transportation noises, and to determine the validity of a "personal noise exposure index" model for community noise impact representation. Specific research work consists of: developing the "personal noise exposure index" model; measuring the daily noise exposure of 30 to 50 individuals; correlating noise exposure, noise sources and reported annoyance; evaluating the usefulness of the analytical model and developing a plan for its refinement if the concept is judged beneficial.

Two alternative approaches to measuring human response to noise have been tested, and two separate plans developed for a national noise measurement program. Results of this research are published in a series of four Government technical reports.

Funding levels for this project are $130,000 for FY 74 and $50,000 for FY 75; about $295,000 was funded for this program prior to FY 73.

7. DOC(NBS)

NBS has a major research effort in individual behavior effects.

NBS' objectives in noise health effects are to: establish a more consistent and valid psychophysical foundation for measuring the effects of sound on people with application to noise abatement and control; develop new measurement procedures for obtaining psychoacoustic data and elaborate through empirical experiments an interlocking system of techniques for assessing human response to sound with built-in opportunities for cross-validation.

The NBS program in psychoacoustic measurement has one current project, titled Psychoacoustic Measurement Techniques, and funded as follows:

FY 73:	$ 98,000
FY 74:	$117,000
FY 75:	$142,000.

Specific NBS project activity on loudness measurement includes: analyzing previous research on loudness, noisiness, and aversiveness of sounds; evaluating the psychoacoustic measurement techniques as applied to standardizing methods for calculating the loudness, noisiness, annoyance, etc., of sound; and developing new psychoacoustic measurement techniques based on operational definitions of behavioral responses with the biases due to verbal instruction minimized.

Equal aversion levels have been established for pure tones and 1/3-octave measures, the aversiveness of three full-octave bands were determined and compared with auditory-evoked potential brain wave recordings from the subjects; the preference relations among various acoustic stimuli were examined by means of a binary switching response not involving verbal descriptors. In addition, a variable interval schedule was used to determine the relative aversiveness of several pure tone stimuli.

Extension of the work calls for establishing preference relations among sounds of varying frequency and intensity using pure tones and white noise; determining the relative aversiveness of sound of different spectral content and cross-validating by different methodologies.

8. HUD

HUD has major research efforts in two categories, community or collective response and measurement methodology and calibration.

8.1 Community or Collective Response

HUD pursues research in community or collective response in order to provide the necessary RD&D to technically support the Department's policies and operating programs and to provide guidance for land usage near major noise sources. Prior HUD research has provided technical background for the preparation of two documents, "HUD Noise Abatement Guidelines" and "HUD Noise Assessment Guidelines" which have been widely distributed for use in implementing the supporting Department policy.

HUD's current program of research on community or collective response consists of two projects, funding levels for which are shown in Table D-18. The following specific project work is being performed:

- HUD is conducting a comprehensive nationwide study and systematic evaluation of the effectiveness and impact of the Department's noise policy and of its "Noise Assessment Guideline." The work is being pursued with a view toward their revision and improvement.

- HUD also expects to initiate a broad study of the effects of noise on community development in FY 75. This will include work on acoustical criteria for various land use ordinances and building codes, the

Table D-18

HUD RESEARCH IN COMMUNITY OR COLLECTIVE RESPONSE

Projects in Community or Collective Response	Funding Level (Thousands of Dollars) FY 73	FY 74	FY 75
1. Evaluation of HUD Noise Policies and Guidelines	0	200	185
2. Effects of Noise on Community Development	0	0	225
TOTALS	0	200	410

Table D-19

HUD RESEARCH IN MEASUREMENT METHODOLOGY AND CALIBRATION

Projects in Measurement Methodology and and Calibration	Funding Level (Thousands of Dollars) FY 73	FY 74	FY 75
1. HUD Urban Noise Measurement System	117	263	0
2. Development of Noise Attenuation Measures	0	175	50
TOTALS	117	438	50

effects of noise on housing markets and land values, and the noise compatibility of intra- and inter-urban transportation with community development.

8.2 Measurement Methodology and Calibration

HUD research in measurement methodology is directed toward developing measurement systems for use in enforcing HUD departmental standards on noise abatement and control. The agency has one program of two specific research projects in this category as shown in Table D-19 on page 40.

Under this program HUD funded a project performed by NBS in FY 74 to develop an inexpensive portable urban noise exposure measurement system which separates potential housing sites into "clearly acceptable" or "clearly unacceptable" for HUD housing and to demonstrate a measurement system for evaluating sites not clearly within either of these categories as an alternative to acquiring needed data through a full-scale survey.

In pursuance of HUD goals, NBS is developing an instrumentation system consisting of two units, an outdoor "monitor" which is left on the building site and a "reader" which interrogates the monitor. The monitor will be a self-contained, battery-operated unit which registers, on internal memory, the times in any 24-hour period during which the noise level exceeded 45, 65, 75, and 80 dBA. Seventeen units are being procured by HUD for field test by NBS in cooperation with HUD field offices. Additionally, the instruction manual developed by NBS will be field tested.

NBS is also assisting HUD in the comprehensive evaluation of the noise measurement systems in HUD Regional, Area and Insuring Offices across the nation.

9. EPA

EPA has current research efforts in six of the eight categories of health effects research. This includes a major research effort in individual behavior effects plus research efforts in the following categories:

- Noise-induced hearing loss
- Nonauditory health effects
- Individual behavior effects
- Noise effects on sleep
- Communication interference
- Measurement methodology and calibration.

9.1 Noise-Induced Hearing Loss

Determination of effects of noise and vibration on hearing sensations and on human performance. This included investigation of the effects on human performance of whole body vibration combined with a random amplitude modulated pure tone presented to the auditory system (FY 74 $25,000).

Effects of long exposure to noise on hearing threshold. Research includes investigations to determine whether recovery from an asymptotic auditory temporary threshold shift is independent of the duration at which temporary threshold shift is maintained at an asymptotic level. Exposures are made for continuous noise for 24 and 48 hours. Intermittent exposures will be included in subsequent experiments. Other studies are to be conducted in natural living environments under controlled noise exposures of 48-60 hours (FY 74 $25,000), (FY 74 $70,000).

9.2 Nonauditory Health Effects

Determination of nonauditory system adaptation effects to long-term repetitive and varying noise. Studies explore the role of various stimulus, psychological and methodological variables in the elicitation and adaptation of nonauditory physiological system reactions to sound or noise. Peripheral blood volume and heart rate of groups of people will be monitored where ambient acoustic conditions are interrupted with intrusive auditory stimuli (FY 74 $186,000-2 year study).

9.3 Individual Behavior Effects

Study of behavioral correlates of varying noise environments. A systematic review of the literature for the past five years is being made of the effects of specified noise parameters on motor skills performance. Studies are being conducted to evaluate the behavioral effects of specified noise environments on motor skill tasks of varying complexity across subjects matched on relevant personality and motor skills characteristics (FY 74 $50,000), (FY 75 $50,000).

Studies on the time varying noise effects on human responses. These studies include the relationships between human responses and physical parameters of noise for evaluating descriptions of environmental noise. Verbal and non-verbal descriptors are utilized in determining and evaluating responses (FY 75 $75,000). Vigilance performance in the presence of unwanted intermittent noise is being studied using primates (FY 75 $10,000).

9.4 Sleep Interference

Correlational analysis of foreign and domestic scientific data on the effects of noise on human sleep (FY 75 $17,000).

9.5 Communication Interference

Determination of improved criteria for verbal communication including schools, home and laboratory. Analyses of speech and ambient noise levels are being made at the ear during normal and relaxed conversations in the home, schools, and laboratory. Additionally, category scale ratings of the noise environments are being conducted in terms of overall rating of the noise environment and in terms of speech communication (FY 74 $59,000), (FY 75 $62,000).

Obtain more complete data on the spectrum and temporal distribution of speech. A wide range of speakers, including male, female, adult, and children, will be used (FY 75 $25,000).

9.6 Measurement Methodology and Calibration

EPA's program in measurement methodology included one project titled "Instrumentation and Measurement Systems" (FY 73 $24,000), (FY 74 $32,000). This project was directed toward development of a personal noise exposure meter with the work being performed at NBS. Specific project activity included an evaluation of instruments and measurement systems for recording exposures of individuals and developing and demonstrating the capabilities of a measurement system which will record the integrated level above a threshold of dBA over each one-hour period during a 24-hour day. The system consists of a monitor worn by the individual and a reader which interrogates the monitor.

10. DOI(BuMines)

Bureau of Mines has three projects in effects of noise in relation to mine safety and health. Two projects address the problem of the miner's ability to hear "roof talk" warning signals while wearing hearing protection, and the other project is the state-of-the-art in portable calibration of audiodosimeters. The titles and funding are shown in Table D-20.

10.1 Communication Interference

The project "Aspects of Noise Generation and Hearing Protection in Underground Coal Mines" was begun in FY 72 and was completed in FY 73. The objective of this study was to quantitatively identify the spectral and amplitude characteristics of coal mine warning signals and assess the feasibility of using personal ear protection to minimize noise exposure but not impair miners' safety. A report (NTIS No. PB219087) with the same title as the project was published in November 1972. Roof talk warning signals and roof talk and speech discrimination with ear protection were quantified for the Pittsburgh coalbed. The study indicated that ear protection is acceptable when there are high background noises but that the ear protection should be removed when noise sources are not present.

Table D-20

DOI(BuMines)
NOISE EFFECTS RESEARCH

	Funding Levels (Thousands of Dollars)		
	FY 73	FY 74	FY 75
Projects in Communication Interference			
1. Aspects of Noise Generation and Hearing Protection in Underground Coal Mines	1	0	0
2. Study of Roof Warning Signals and the Use of Personal Hearing Protection in Underground Coal Mines	71	8	0
Projects in Measurement Methodology and Calibration			
Portable Calibration Instrumentation for Audiodosimeters - Feasibility Study	0	15	0
TOTALS	72	23	0

The project "Study of Roof Warning Signals and the Use of Personal Hearing Protection in Underground Coal Mines" extended the previous study of roof warning signals to other (high-accident) coalbeds. It also determined the effects of personal hearing protection on miners' safety with a larger number of subjects. A training course in the use of personal hearing protection in coal mines was also developed.

10.2 Measurement Methodology and Calibration

The Bureau of Mines' project in this category is intended to determine the state-of-the-art in audio acoustic couplers and the associated electronic interface. The output will be a report giving the state-of-the-art tthe specifications achievable with existing technology for a portable calibration instrument for audio dosimeters, and a proposal for design and fabrication of an achievable calibrator.

APPENDIX E

PROJECT LISTING BY AGENCY

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E-10	U.S. Environmental Protection Agency	E-25
E-11	Department of Agriculture	E-29
E-12	Bureau of Mines	E-29

Table E-1
RESEARCH FUNDING BY AGENCY
(page 1 of 3 pages)
NATIONAL INSTITUTE OF NEUROLOGICAL DISEASES AND STROKE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76	FY-77	FY-78	FY-79
	4403-12(Grant)	Susceptibility to Hearing Loss	220		45	47	49	51			
	3705-09(Grant)	Causes of Deafness	2,480		365	387	413	440			
	NO1 NS 03-56-11 (Grant)	Auditory Communications and its Disorders	(3,773)[1]		(461)[1]	(586)[1]	(598)[1]	(615)[1]	(613)[1]	(642)[1]	
Noise-Induced Hearing Loss	NS-09983(Grant)	Noise Effects on Audiogram and Cochlea	37		37						
	Planned Contract	Economic[2] and Social Impacts of Noise Induced Hearing Loss						150	300	300	
	NS-74-0001 (Contract)	Effect of[3] Noise on Children				20					
	In-House Research	Laboratory of[4] Otolaryngology				28	15	15	20	21	21

Table E-1
RESEARCH FUNDING BY AGENCY
(Page 2 of 3 pages)
NATIONAL INSTITUTE OF NEUROLOGICAL DISEASES AND STROKE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76	FY-77	FY-78	FY-79
	Planned Work	Experimental Studies of Effects of Noise on Young Ears (Primates)					340	550	500	600	350
	Planned Contract	Auditory Responses in Quiet and Noise Among Very Young Children					120	250	400	440	500
		Presbycusis							40	125	250
	Planned Contract	Auditory Sensitivity and Discrimination Among Children Living in Noisy Environments					120	300	330		
Non-Auditory Health Effects	Planned Work	Effects of Noise on Susceptibility to Disease						120	200	250	400

Table E-1
RESEARCH FUNDING BY AGENCY
(Page 3 of 3 pages)
NATIONAL INSTITUTE OF NEUROLOGICAL DISEASES AND STROKE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76	FY-77	FY-78	FY-79
	NS-07908-07	Noise-Induced Deafness: Masking & Speech Perception	461		79						
Communication Interference	NS-74-2322 (Contract)	Development of Test Instrument for Assessing Speech Discrimination in Noise				140	100		100	100	100
		Message Transmission in Noise									130
Subtotals by Category	Noise-Induced Hearing Loss				447	482	1057	1756	1590	1486	1121
	Non-Auditory Health Effects							120	200	250	400
	Communication Interference				79	140	100	—	100	100	230
TOTALS					526	622	1157	1876	1890	1836	1751

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[1] Project funding covers work in other areas and is not included

[2] Initiated in FY-75 only if additional funds become available

[3] Includes study of non-auditory effects of noise

[4] Portion of laboratory's effort oriented towards effects of noise

Table E-2
RESEARCH FUNDING BY AGENCY
(Page 1 of 2 pages)

NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76	FY-77	FY-78	FY-79
Noise-Induced Hearing Loss	NIEHS-EB-002	Investigation of Hearing Loss Threshold Curve for Young versus Mature Animals			25	25					
	NIEHS-EB-002	Combined Effect of Noise and Salicylates on Cochlear Morphology & Auditory Threshold			20						
	RO1 ES 969	Combined Impulse-Continuous Noise: Auditory Effect				51	44	44	45		
	NIEHS-EB-009	Identification of Physiological Dysfunction in Neurosensory Hearing Loss Induced by Ototoxic Agents				8	29	29	29	29	
	NIEHS-EB-008	Physiological Study of Auditory Fatigue (Induced by Noise)				8	26	26	26	26	

Table E-2
RESEARCH FUNDING BY AGENCY
(Page 2 of 2 pages)
NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76	FY-77	FY-78	FY-79
	NOL-ES-2110	Interaction of Noise & Ototoxic Drugs on Hearing Loss in Animals			100	100	100				
Non-Auditory Health Effects	NIEHS-EB-011	Effects of Noise on Corticosterone Secretion in the Rat				16					
	NIEHS-EB-012	Noise Polymorphonuclear Leukocyte Function				12	8				
	NIEHS-EB-013	Noise & Cellmediated Immunity				28	24				
	NIEHS-ET-003	Teratogenic Effects of Noise Exposure and Deprivation				10	8				
	NIEHS-EB-004	Noise in the Hospital			8						
Subtotals by Category		Noise-Induced Hearing Loss			145	192	199	99	100	55	
		Non-Auditory Health Effects			8	66	40	—	—	—	
TOTALS					153	258	239	99	100	55	

Table E-3
RESEARCH FUNDING BY AGENCY
(Page 1 of 5 pages)
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
(Thousands of Dollars)

Category	Project Number[2]	Project Title[2]	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75[1]	FY-76
Noise-Induced Hearing Loss		Evaluation[3] of Hearing Risk due to Industrial Noise			75	79	104	
		Short Term Physical Agents Research: Coal Mine Noise[3]			35	10	0	
	HSM 99-72-125	Evaluation of Industrial Acoustic Radiation above 10 KH_z		40			0	
	HSM 99-72-32	PTS and TTS Resulting from Industrial Noise Exposure		24			0	
	PL 480 Foreign Currency Agreement No. 05-005-3	Effects of Noise and Vibration on Health of Woodcutters	213 7/68-9/74	X	X	X		

Table E-3
RESEARCH FUNDING BY AGENCY
(Page 2 of 5 pages)
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
(Thousands of Dollars)

Category	Project Number[2]	Project Title[2]	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75[1]	FY-76
	PL480 Foreign Currency Agreement #03-002-03	Exposure to Noise in the Cotton & Flax Textile Industry	99 7/71-7/75	X	X	X	X	X
		Laboratory Studies of Noise-Induced Hearing Loss				87	91	
		Combined Effects[3] on Noise, Work & Heat on Human Hearing			24	18		
	HSM 99-72-131	Aspect of Ear Tolerance to Noise			50	0	0	
	NIOSH-IA-73-6	Laboratory & Field Study of Impact Noise			40		0	
	Grant (EOA) Ro1-OH000350	Damage Risk Criteria for Intermittent Noise Exposure				56	47	41

Table E-3
RESEARCH FUNDING BY AGENCY
(Page 3 of 5 pages)
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
(Thousands of Dollars)

Category	Project Number[2]	Project Title[2]	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75[1]	FY-76
	PL480 Foreign Currency Agreement #05-0142	Noise and Heat Effects on Man		167 5/72-4/77	X	X	X	X
	Grant (OEA) 1 R01 OH00364	Effects of Impulse Noise on the Auditory System				91	69	76
		Noise and Hearing in the Paper Working Industry					41	
Non-Auditory Health Effects		Extra Auditory Consequence to Worker Safety and Health				42		
		Effects of Noise on Non-Auditory Sensory Functions and Performance			78		21	
		Health Impact of Industrial Noise					New	

Table E-3
RESEARCH FUNDING BY AGENCY
(Page 4 of 5 pages)
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Category	Project Number[2]	Project Title[2]	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
		Effects of Noise and Heat on Health of Workers in Metal Industry			30			
Individual Behavior Effects	Grant R01 OH-00366	Effects of Three Sound Environments on Human Behavior				8	0	
	Grant R01 OH-00365	Noise and Human Performance				20	0	
		Noise and Industrial Accidents					New	
Measurement Methodology & Calibration		Industrial[3] Audiometric & Hearing Conservation Technology			31	52	80	

Table E-3
RESEARCH FUNDING BY AGENCY
(Page 5 of 5 pages)
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
(Thousands of Dollars)

Category	Project Number[2]	Project Title[2]	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75[1]	FY-76
		Measurement[3] of Occupational Noise			32	44	28	
Sub-totals by Category		Noise-Induced Hearing Loss		64	224	341	352	117
		Non-Auditory Health Effects			108	42	21	
		Individual Behavior Effects				28		
		Measurement Methodology and Calibration			63	96	108	
TOTALS				64	395	507	481	117

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[1] Figures Approximate

[2] NIOSH does not use the term "Project" for this level of research activity

[3] Project titles were not the same in FY 73

Table E-4
RESEARCH FUNDING BY AGENCY
(Page 1 of 6 pages)
DEPARTMENT OF DEFENSE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75
Noise-Induced Hearing Loss	DAOA-6082 (USA)	Military Performance - Traumatic Origins of Hearing Loss		X			
	DNOA-4956 (USA)	Relationship of Hearing Change to Acoustic Inputs			62	66	
	DAOC-7028 (USA)	Prevalence of Hearing Loss within Selected U.S. Army Branches				20	
	DAOB-7030 (USA)	Hearing Conservation Intense Acoustic Stimulation and Noise Susceptibility in the Military Environment			46		
	DN-123487 (USN)	Communications: Hearing of Naval Personnel as a Function of Noise Exposure			20		
	DN-240004 (USN)	Study of Anatomic Changes in Middle Ear Associated with Noise-Induced Hearing Loss and Acoustic Trauma			10	19	
	DN-240059 (USN)	Middle Ear Compliance and Its Relationship to Military Related Noise-Induced Hearing Loss & Acoustic Trauma			8	13	

Table E-4
RESEARCH FUNDING BY AGENCY
(Page 2 of 6 pages)
DEPARTMENT OF DEFENSE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75
Noise - Induced Hearing Loss	DN-477001 (USN)	The Incidence of Hearing Loss Among Various Navy Related Personnel				50	
	DN-140504 (USN)	Development of Damage Risk Criteria and Habitability Standards for Exposure to Sonar Transmissions			20	25	
	DF-311650 (USAF)	Effects of Noise on Air Force Personnel in Operational Environments			20	49	
	DF-314140 (USAF)	Research on Permanent and Temporary Shifts in Hearing Threshold Produced by Exposure to Air Force Noise				2	
	DF-313060 (USAF)	Auditory Responses to Acoustic Energy Experienced in Air Force Activities			24	22	
	DF-317610 (USAF)	Human Subjects for Operating Acoustic Research			38	35	

Table E-4
RESEARCH FUNDING BY AGENCY
(Page 3 of 6 pages)
DEPARTMENT OF DEFENSE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75
Non-Auditory Health Effects	DR-313120	Research on Response of Vestibular System to Acoustic Stimuli		X	10		
Individual Behavior Effects	DAOB-4955 (USA)	Improved Weapon Noise Exposure Criteria			62	66	
	DN-840511 (USN)	Optimization of Performance in Submarines			54	44	
	DN-040711 (USN)	Optimization of Auditory Performance in Naval Aviation			40	35	
	DR-313100 (USAF)	Simultaneous Exposure to Acoustic Energy and Other Stressors Found in the Air Force Environments		X	7	3	
	DF-313070 (USAF)	Whole-body Effects of Air Force Noise on People		X	24	18	
	DF-028540 (USAF)	Research on Intermittent Noise Effects on Air Force Target Detection Tasks		X	46		

Table E-4
RESEARCH FUNDING BY AGENCY
(Page 4 of 6 pages)
DEPARTMENT OF DEFENSE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75
	DAOA-6085 (USA)	Military Performance: Auditory Perception and Psychophysics			X		
	(USA)	Human Engineering Studies of the Head and Headgear, Helmet Acoustics, Weight, plus Other Factors Affecting Performance				X	
Communication Interference	(USN)	Sound Conduction in the Ear Affecting Military Communications		X	26		
	DN-040713 (USN)	Optimization of Speech Communications in Naval Aviation			40	40	
	DN-140502 (USN)	Development of Auditory Screening and Acoustical Tolerance Standards for Submarine/Shipboard Personnel			30	33	
	DF-311640 (USAF)	Assessment of Hearing in Flying Personnel			28	36	
Community or Collective Response	DF-313140 (USAF)	Effects of Air Force Noises on Population Surrounding Air Bases			31		

Table E-4
RESEARCH FUNDING BY AGENCY
(Page 5 of 6 pages)
DEPARTMENT OF DEFENSE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75
Measurement Methodology and Calibration	DAOD-6739 (USA)	Research on Psychoacoustical Problems Medically Significant to Army Aviation		X	85	195	
	DN-612146 (USN)	Airborne Noise Criteria for Ships and Submarines			69	74	
	DF-314500 (USAF)	Development and Updating of Air Force Land Use Planning Procedure with Respect to Aircraft Noise			32		
	DF-316600 (USAF)	Measurement and Analysis of Aircraft Noise Environments for Developing New Air Force Procedures to Forecast Noise Exposure			13	15	
	DF-313020 (USAF)	Mechanisms of Noise Generation and Reception as Related to Air Force Bioacoustic Programs			3	2	
	DF-313030 (USAF)	Bioacoustic Environments of USAF Aerospace Systems			92	68	

Table E-4
RESEARCH FUNDING BY AGENCY
(Page 6 of 6 pages)
DEPARTMENT OF DEFENSE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75
	DF-317570 (USAF)	Bioenvironmental Noise Research Program			43		
Sub-totals by Category	Noise-Induced Hearing Loss				248	301	301*
	Non-Auditory Health Effects				10	0	0 *
	Individual Behavior Effects				233	166	166*
	Communication Interference				124	109	109*
	Community or Collective Response				32	0	0 *
	Measurement Methodology and Calibration				337	354	354*
TOTALS					984	930	930*

* DOD FY 75 data estimated the same as FY 74

Table E-5
RESEARCH FUNDING BY AGENCY
(Page 1 of 1 page)
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-73	FY-74	FY-75
Noise Effects on Sleep	504-09-02	Human Response to the Aeronautical Environment		217	254	142
Community or Collective Response	504-29-01	Acceptance of Aircarft Operations-Technical Assessment		173	172	232
	504-29-11	Acceptance of Aircraft Operations-Communicy Noise		205	319	422
Measurement Methodology and Calibration	504-29-11	Acceptance of Aircraft Operations		532	409	404
Subtotals by Category		Noise Effects on Sleep		217	254	142
		Community or Collective Response		378	491	654
		Measurement Methodology and Calibration		532	409	404
TOTALS				1,127	1,154	1,200

Table E-6
RESEARCH FUNDING BY AGENCY
(Page 1 of 1 page)
DEPARTMENT OF TRANSPORTATTON
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
	Work at DOC/ NBS (USCG)	Foghorn Aversiveness Study			5			
Individual Behavior Effects	AM-B-73-PSY-41 (FAA)	Field Study of Sonic Boom Startle Effects		X	18			
	AM-B-73-PSY-31 (FAA)	Determinants of Startle Response to Simulated Sonic Booms		X	27			
	(DOT/FAA/DOD/ USAF)	Animal Response to Impulsive Acoustic Stimuli		38	0			
Community or Collective Response	Contract 036369 (Trais No.) (ONA)	Measurement of Community Noise and Associated Human Response	295			130	50	
Subtotals By Category		Individual Behavior Effects		38	50			
		Community or Collective Response	295	—	—	130	50	
	TOTALS		295	38	50	130	50	

Table E-7
RESEARCH FUNDING BY AGENCY
(Page 1 of 2 pages)
NATIONAL SCIENCE FOUNDATION
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
Noise - Induced Hearing Loss	GB-36652	Noise Trauma, Ototoxicity and the Olivocochlear Bundle			20			
	8-72	Permanent Effects of Noise on Low and Mid Frequency Hearing		X				
	01	Interaction of Ototoxic Drugs with Acoustic Trauma		X				
Non-Auditory Health Response	01	Effect of Noise on Cardiovascular Changes in Non-Cardiac patients in ICU	X					
Individual Behavior Effects	GS-33216	Collaborative Research on Social Psychological Reactions to Stress		34				
	GS-2405A #2	Collaborative Research on Social Psychological Reactions to Stress		42				

Table E-7
RESEARCH FUNDING BY AGENCY
(Page 2 of 2 pages)
NATIONAL SCIENCE FOUNDATION
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
	GS-34329	Collaborative Research on Social Psychological Reactions to Stress		39				
Subtotals by Category		Noise-Induced Hearing Loss			20			
		Non-Auditory Health Response						
		Individual Behavior Effects		115				
TOTALS			X	115	20			

Table E-8
RESEARCH FUNDING BY AGENCY
(Page 1 of 1 page)
NATIONAL BUREAU OF STANDARDS
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
Individual Behavior Effects		Psychoacoustic Measurement Techniques		64	98	117	142	140

Table E-9
RESEARCH FUNDING BY AGENCY
(Page 1 of 1 page)
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
(Thousands of Dollars)

Category	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76	FY-77	FY-78
Community or Collective Response	Evaluation of HUD Noise Policies & Guidelines				200	185			
	Effects of Noise on Community Development					225			
Measurement Methodology & Calibration	HUD Urban Noise Measurement System			117	263				
	Development of Noise Attenuation Measures				175	50			
Subtotals by Category	Community or Collective Response				200	410			
	Measurement Methodology & Calibration			117	438	50			
TOTALS				117	638	460			

Table E-10
RESEARCH FUNDING BY AGENCY
(Page 1 of 4 pages)
U.S. ENVIRONMENTAL PROTECTION AGENCY
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
Noise-Induced Hearing Loss	IAG	Evaluation of Effects of Noise Exposure Combined with Other Stressing Agents on Hearing & Performance				25		
	IAG & Contract	Evaluation of Long-term Noise Exposure on Hearing				25	70	
		Differentiation between Noise-Induced Hearing Loss and Presbycusis						600
		Auditory Effects from Moderate Noise Levels						
		Auditory Effects from Intermittent Daily Exposures						
		Longitudinal Studies of Auditory Effects From Noise Exposure						

Table E-10
RESEARCH FUNDING BY AGENCY
(Page 2 of 4 pages)
U.S. ENVIRONMENTAL PROTECTION AGENCY
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
Non-Auditory Health Effects		Interactive Effects of Noise and Other Influences						700
	Contract	Studies of Non-Auditory Physiological Effects				186*		
Individual Behavior Effects	IAG	Behavior Correlation of Varying Noise Environments				50	50	
	In-House	Vigilance Task Performance in Presence of Intermittent Unwanted Noise in Primates					10	
	IAG	Time-Varying Effects on Human Response					75	150
		Effects on Task Performance						
Noise Effects on Sleep		Quality of Sleep & Effects Related to Psysiological & Psychological Implications						150
	Contract	Correlation of Foreign & Domestic Data on Human Sleep					17	

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* 2 Year Period

Table E-10
RESEARCH FUNDING BY AGENCY
(Page 3 of 4 pages)
U.S. ENVIRONMENTAL PROTECTION AGENCY
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
Communication Interference	Contract	Improved Criteria for Verbal Communication From Noise in Schools and Home Environment				59	62	200
	IAG	Voice Levels & Environmental Noise Conditions that Permit Adequate Speech Communication					25	
		Effect of Age, Speech Level, Hearing on Reliable Communication						
Community or Collective Response		Effects of Noise on Community Response Related to Annoyance						200
		Identify Environmental Noise Levels for Determining Cumulative Dose Exposures for Different Population Segments						
		Identify Sociological Effects of Noise						

Table E-10
RESEARCH FUNDING BY AGENCY
(page 4 of 4 pages)
U.S. ENVIRONMENTAL PROTECTION AGENCY
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
Measurement Methodology & Calibration	Work at DOC(NBS)	Instrumentation & Measurement Systems for Noise Exposure of Individuals			24	32		
Subtotals By Category	Noise-Induced Hearing Loss					50	70	600
	Non-Auditory Health Effects					186*	0	700
	Individual Behavior Effects					50	135	150
	Noise Effects on Sleep						17	150
	Communication Interference					59	87	200
	Community or Collective Response							200
	Measurement Methodology & Calibration				24	32		
TOTALS					24	377	309	2,000

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* 2 Year Period

Table E-11
RESEARCH FUNDING BY AGENCY
(Page 1 of 1 page)
DEPARTMENT OF AGRICULTURE
(Thousands of Dollars)

Category	Project Number	Project Title	Total Prior to Initial Year Indicated	FY-72	FY-73	FY-74	FY-75	FY-76
Domestic Animals & Wildlife	0057475 SC-00945	The Effect of Noise Pollution on the Fowl	X	X	X	X		

Table E-12
RESEARCH FUNDING BY AGENCY
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
(Thousands of Dollars)

Category	Project Number	Project Title	FY-73	FY-74	FY-75
Communication Interference	GO 122004	Aspects of Noise Generation & Hearing Protection in Underground Coal Mines	1	0	0
	GO 133026	Study of Roof Warning Signals & the Use of Personal Hearing Protection in Underground Coal Mines	71	8	0
Subtotals for Communication Interference			72	8	0
Measurement Methodology & Calibration	SO 144091	Portable Calibration Instrumentation for Audiodosimeters--Feasibility Study	0	15	0
		Agency Total	72	23	0

Table F-1
NOISE-INDUCED HEARING LOSS
(Page 1 of 9 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars							
				FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
HEW/ NINDS	4403-12 (Grant)	Susceptibility to Hearing Loss	220		45	47	49	51			
	5785-09 (Grant)	Causes of Deafness	2,480		365	387	413	440			
	RO1 NS 03856-11 (Grant)	Auditory Communications and its Disorders	3,773[1]		461[1]	(586)[1]	(598)[1]	(615)[1]	(613)[1]	(642)[1]	
	NS-09983 (Grant)	Noise Effects on Audiogram and Cochlea	36		37						
	Planned Contract	Economic and Social Impacts of Noise-Induced Hearing Loss[2]					0	150	300	300	
	NS-74-0001 (Contract)	Effect of Noise on Children[3]				20	0	0	0	0	
	In-house Research	Laboratory of Otolaryngology[4]				28	15	15	20	21	21
	Planned work	Experimental Studies of Effects of Noise on Young Ears (Primate)	0	0	0	0	340	550	500	600	350

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[1] Project funding covers work in other categories and is not included in totals.
[2] Initiated in FY 75 only if additional funds become available.
[3] Includes study of non-auditory effects of noise.
[4] Portion of laboratory's effort oriented toward noise effects.

Table F-1
NOISE-INDUCED HEARING LOSS
(Page 2 of 9 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
HEW/ NINDS	Planned work	Auditory Responses in Quiet and Noise Among Very Young Children	0	0	0	0	120	250	400	440	500
	Planned work	Presbycusis	0	0	0	0	0	0	40	125	250
	Planned work	Auditory Sensitivity and Discrimination Among Children Living in Noisy Environments					120	300	330		
	Subtotals		2,737		447	482	1,057	1,756	1,590	1,486	1,121
HEW/[2] NIOSH		Evaluation of Hearing Risk due to Industrial Noise[3]			(75)[3]	79	104[1]				
		Short Term Physical Agents Research: Coal Mine Noise[3]			(35)[3]	10	0				

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[1] Estimated.

[2] NIOSH does not use the term "project" for this level of research activity.

[3] Project titles were not the same in FY 73.

Table F-1
NOISE-INDUCED HEARING LOSS
(Page 3 of 9 Pages)

				Reported Funding, Thousands of Dollars							
Agency	Project No.[2]	Project Title[2]	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY[1] 75	FY 76	FY 77	FY 78	FY 79
HEW/ NIOSH		Noise and Hearing in the Paperworking Industry			0	0	41				
	HSM 99-72-125	Evaluation of Industrial Accoustic Radiation above 10 KH_z		40							
	HSM 99-72-32	PTS and TTS Resulting from Industrial Noise Exposure		24							
	PL 480 Foreign Currency Agreement No. 05-005-3	Effects of Noise and Vibration on Health of Woodcutters	213 7/68-9/74	x	x	x					
	PL 480 Foreign Currency Agreement No. 03-002-03	Exposure to Noise in the Cotton and Flax Textile Industry	99 7/71-7/75	x	x	x	x	x			
		Laboratory Studies of Noise-Induced Hearing Loss				87	91				

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[1] Estimated.

[2] NIOSH does not use the term "project" for this level of research activity.

Table F-1
NOISE-INDUCED HEARING LOSS
(Page 4 of 9 Pages)

Agency	Project No.[2]	Project Title[2]	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars							
				FY 72	FY 73	FY 74	FY[1] 75	FY 76	FY 77	FY 78	FY 79
HEW/ NIOSH	[2]	Combined Effects of Noise, Work and Heat on Human Hearing[3]			(24)[3]	18					
	HSM 99-72-131	Aspects of Ear Tolerance to Noise			50						
	NIOSH-LA-73-6	Laboratory and Field Study of Impact Noise			40						
	Grant (OEA) R01-OH000350	Damage Risk Criteria for Intermittent Noise Exposure				56	47	41			
	PL-480-Foreign Currency Agreement No. 05-0142	Noise and Heat Effects on Man		167 5/72-4/77	x	x	x	x			
	Grant (OEA) 1R01 OH 00364	Effects of Impulse Noise on the Auditory System				91	69	76			
		Subtotals		64	224	341	352	117			

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[1] Estimated.

[2] NIOSH does not use the term "project" for this level of research activity.

[3] Project titles were not the same in FY 73.

Table F-1
NOISE-INDUCED HEARING LOSS
(Page 5 of 9 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
HEW/ NIEHS	NIEHS-EB-002	Investigation of Hearing Loss Threshold Curve for Young vs. Mature Animals			25	25					
	NIEHS-EB-002	Combined Effect of Noise and Salicylates on Cochlear Morphology and Auditory Threshold			20						
	R01-ES-969	Combined Impulse-Continuous Noise: Auditory Effect				51	44	44	45		
	NIEHS-EB-009	Identification of Physiological Dysfunction in Neurosensory Hearing Loss Induced by Ototoxic Agents				8	29	29	29	29	
	NIEHS-EB-008	Physiological Study of Auditory Fatigue (Induced by Noise				8	26	26	26	26	
	NOL-ES-2110	Interaction of Noise and Ototoxic Drugs on Hearing Loss in Animals			100	100	100				
		Subtotals			145	192	199	99	100	55	

Table F-1
NOISE-INDUCED HEARING LOSS
(Page 6 of 9 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOD	DAQA-6082 (USA)	Military Performance-Traumatic Origins of Hearing Loss		x							
	DNOA 4956 (USA)	Relationship of Hearing Change to Acoustic Inputs			62	66					
	DAOC 7028 (USA)	Prevalence of Hearing Loss within Selected U.S. Army Branches				20					
	DAOB-7030 (USA)	Hearing Conservation Intense Acoustic Stimulation and Noise Susceptibility in the Military Environment			46						
	DN-123487 (USN)	Communications: Hearing of Naval Personnel as a Function of Noise Exposure			20						
	DN-240004 (USN)	Study of Anatomic Changes in Middle Ear Associated with Noise-Induced Hearing Loss and Acoustic Trauma			10	19					

Table F-1
NOISE-INDUCED HEARING LOSS
(Page 7 of 9 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOD	DN-240059 (USN)	Middle Ear Compliance and Its Relationship to Military Related Noise-Induced Hearing Loss and Acoustic Trauma			8	13					
	DN 477001 (USN)	The Incidence of Hearing Loss Among Various Navy Related Personnel				50					
	DN 140504 (USN)	Development of Damage Risk Criteria and Habitability Standard for Exposure to Sonar Transmissions			20	25					
	DF-311650 (USAF)	Effects of Noise on Air Force Personnel in Operational Environments			20	49					
	DF-314140 (USAF)	Research on Permanent and Temporary Shifts in Hearing Threshold Produced by Exposure to Air Force Noise				2					

Table F-1
NOISE-INDUCED HEARING LOSS
(Page 8 of 9 Pages)

				Reported Funding, Thousands of Dollars							
Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOD	DF-313060 (USAF)	Auditory Responses to Acoustic Energy Experienced in Air Force Activities			24	22					
	DF-317610 (USAF)	Human Subjects for Operating Acoustic Research			38	35					
		Subtotals			248	301	301*				
NSF	GB-36652	Noise Trauma, Ototoxicity and the Olivochochlear Bundle			20						
	8-72	Permanent Effects of Noise on Low and Mid Frequency Hearing		x							
	01	Interaction of Ototoxic Drugs with Acoustic Trauma		x							
		Subtotals			20						

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* DOD FY 75 data estimated the same as FY 74.

Table F-1
NOISE-INDUCED HEARING LOSS
(Page 9 of 9 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars							
				FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
EPA	IAG	Evaluation of Effects of Noise Exposure Combined with Other Stressing Agents on Hearing. and Performance				25					
	IAG and Contract	Evaluation of Long-Term Noise Exposure on Hearing				25	70				
		Differentiation Between Noise-Induced Hearing Loss and Presbyacusis									
		Auditory Effects from Moderate Noise Levels						600			
		Auditory Effects from Intermittent Daily Exposures									
		Longitudinal Studies of Auditory Effects from Noise Exposure									
		Subtotals				50	70	600			
		Totals for Noise-Induced Hearing Loss	2,737	64	1,084	1,366	1,979	2,572	1,690	1,541	1,121

Table F-2
NON-AUDITORY HEALTH EFFECTS
(Page 1 of 3 Pages)

				Reported Funding, Thousands of Dollars							
Agency	Project No.[2]	Project Title[2]	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY[1] 75	FY 76	FY 77	FY 78	FY 79
HEW/ NIOSH		Extra-Auditory Effects of Noise of Consequence to Worker Safety and Health				42					
		Effects of Noise on Non-Auditory Sensory Functions and Performance			78		21				
		Health Impact of Industrial Noise					New				
		Effects of Noise and Heat on Health of Workers in Metal Industry			30						
		Subtotals			108	42	21				

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[1] Estimated.

[2] NIOSH does not use the term "project" for this level of research activity.

Table F-2
NON-AUDITORY HEALTH EFFECTS
(Page 2 of 3 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
HEW/ NIEHS	NIEHS-EB-011	Effects of Noise on Corticosterone Secretion in the Rat				16					
	NIEHS-EB-012	Noise Polymorphonuclear Leukocyte Function				12	8				
	NIEHS-EB-013	Noise and Cellmediated Immunity				28	24				
	NIEHS-EB-004	Noise in the Hospital			8						
	NIEHS-ET-003	Teratogenic Effects of Noise Exposure and Deprivation				10	8				
		Subtotals			8	66	40				
HEW/ NINDS	Planned Work	Effects of Noise on Susceptibility to Disease						120	200	250	400
								120	200	250	400

Table F-2
NON-AUDITORY HEALTH EFFECTS
(Page 3 of 3 Pages)

				Reported Funding, Thousands of Dollars							
Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOD	DR-313120 Contract F33615-69-C-1246 (USAF)	Research on Response of Vestibular System to Acoustic Stimuli			10						
		Subtotals			10						
NSF	01	Effect of Noise on Cardiovascular Changes in Noncardiac Patients in ICU									
EPA		Interactive Effects of Noise and Other Influences						700			
	Contract	Studies of Non-Auditory Physiological Effects				186*					
		Subtotals				186	0	700			
		Totals for Non-auditory Health Effects			126	294	61	820	200	250	400

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*Project funded for 2 year period

Table F-3
INDIVIDUAL BEHAVIOR EFFECTS
(Page 1 of 4 Pages)

Agency	Project No.[1]	Project Title[1]	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
			Reported Funding, Thousands of Dollars								
HEW/ NIOSH	Grant R01 OH-00366	Effects of Three Sound Environments on Human Behavior				8					
	Grant R01 OH-00365	Noise and Human Performance				20					
		Noise and Industrial Accidents					New				
		Subtotals				28					

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[1] NIOSH does not use the term "project" for this level of research activity.

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOD	DAOB-4955 (USA)	Improved Weapon Noise Exposure Criteria			62	66					
	DN 840511 (USN)	Optimization of Performance in Submarines			54	44					
	DN 040711 (USN)	Optimization of Auditory Performance in Naval Aviation			40	35					

Table F-3
INDIVIDUAL BEHAVIOR EFFECTS
(Page 2 of 4 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars							
				FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOD	DR-313100 (USAF)	Simultaneous Exposure to Acoustic Energy and Other Stressors Found in Air Force Environments			7	3					
	DF-313070 (USAF)	Whole-Body Effects of Air Force Noise on People		x	24	18					
	DF-028540 Contract AFOSR-1822-69 (USAF)	Research on Intermittent Noise Effects on Air Force Target Detection Tasks		x	46						
		Subtotals			233	166	166[1]				
DOT	AM-B-73-PSY-41 (FAA)	Field Study of Sonic Boom Startle Effects		x	18						
	AM-B-73-PSY-31 (FAA)	Determinants of Startle Response to Simulated Sonic Boom		x	27						

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[1] DOD FY 75 data estimated the same as FY 74

Table F-3
INDIVIDUAL BEHAVIOR EFFECTS
(Page 3 of 4 Pages)

				Reported Funding, Thousands of Dollars							
Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOT	DOT/FAA/DOD/AF	Animal Response to Impulsive Acoustic Stimuli		38	0						
	Work at DOC/NBS (USCG)	Foghorn Aversiveness Study			5						
		Subtotals		38	50						
NSF	GS-33216	Collaborative Research on Social Psychological Reactions to Stress		34							
	GS-2405A #2	Collaborative Research on Social Psychological Reactions to Stress		42							
	GS-34329	Collaborative Research on Social Psychological Reactions to Stress		39							
NBS	In-house	Psychoacoustic Measurement Techniques			98	17	142				

Table F-3
INDIVIDUAL BEHAVIOR EFFECTS
(Page 4 of 4 Pages)

				Reported Funding, Thousands of Dollars							
Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
EPA	IAG	Behavioral Correlates of Varying Noise Environments				50	50				
	In-house	Vigilance Task Performance in Presence of Intermittent Unwanted Noise in Primates					10				
	IAG	Time varying effects on human response					75				
		Effects on Task Performance						150			
		Subtotals				50	135	150			
		Totals for Individual Behavior Effects		217	381	361	443	290			

Table F-4
NOISE EFFECTS ON SLEEP
(Page 1 of 1 Page)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
			Reported Funding, Thousands of Dollars								
NASA	504-09-02	Human Response to the Aeronautical Environment			217	254	142	150	150		
		Subtotals			217	254	142	150	150		
EPA	Contract	Quality of Sleep & Effects Related to Physiological & Psychological Implications				0	17				
		Correlation of Foreign and Domestic Data on Noise Effects on Sleep									
		Subtotals				0	17				
		Totals for Noise Effects on Sleep			217	254	159	300	150		

Table F-5
COMMUNICATION INTERFERENCE
(Page 1 of 4 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars							
				FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
HEW/ NINDS	NS-07908-07	Noise-Induced Deafness: Masking and Speech Perception	461		79						
	NS-74-2322 (Contract)	Development of Test Instrument for Assessing Speech Discrimination in Noise				140			100	100	100
		Message Transmission in Noise		0	0	0	0	0	0	0	130
		Subtotals	461		79	140	100	0	100	100	230
DOD	DAOA-6085 (USA)	Military Performance: Auditory Perception and Psychophysics									
	(USA)	Human Engineering Studies of the Head and Headgear, Helmet Acoustics, Weight plus Other Factors Affecting Performance			x						

Table F-5
COMMUNICATION INTERFERENCE
(Page 2 of 4 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars							
				FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOD	DN-040713	Optimization of Speech Communications in Naval Aviation			40	40					
	(USN)	Development of Auditory Screening and Acoustical Tolerance Standards for Submarine/Shipboard Personnel			30	33					
	(USN)	Sound Conduction in the Ear Affecting Military Communications			26						
	DF-311640 (USAF)	Assessment of Hearing in Flying Personnel			28	36					
		Subtotals			124	109	109[1]				

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[1] DOD FY 75 data estimated the same as FY 74

Table F-5
COMMUNICATION INTERFERENCE
(Page 3 of 4 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
EPA	Contract	Improved Criteria for Verbal Communication from Noise in Schools and Home Environments				59	62				
	IAG	Voice Levels and Environmental Noise Conditions That Permit Adequate Speech Communication					25				
		Effect of Age, Speech Level, Hearing on Reliable Communication						200			
		Subtotals				59	87	200			
DOI/ BuMines	G0122004	Aspects of Noise Generation & Hearing Protection in Underground Coal Mines			1	0	0				
	G0133026	Study of Roof Warning Signals & the Use of Personal Hearing Protectors in Underground Coal Mines			71	8	0				

Table F-5
COMMUNICATION INTERFERENCE
(Page 4 of 4 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars							
				FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
		Subtotals			72	8	0				
		Totals for Communication Interference	461		275	316	296	200	100	100	230

Table F-6
COMMUNITY OR COLLECTIVE RESPONSE
(Page 1 of 2 Pages)

				Reported Funding, Thousands of Dollars							
Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOT	Contract 036369 (Trais No.)	Measurement of Community Noise and Associated Human Response	295			130	50				
		Subtotals	295			130	50				
NASA	504-29-01	Acceptance of Aircraft Operations Technology Assessment			173	172	232	160	160		
	504-29-11	Acceptance of Aircraft Operations Community Noise			205	319	422	350	350		
		Subtotals			378	491	654	510	510		
DOD	DF 313140	Effects of Air Force Noises on Population Surrounding Air Bases			32	0	0				
		Subtotals			32	0	0				

Table F-6
COMMUNITY OR COLLECTIVE RESPONSE
(Page 2 of 2 Pages)

				Reported Funding, Thousands of Dollars							
Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
HUD		Evaluation of HUD Noise Policies and Guidelines				200	185				
		Effects of Noise on Community Development					225				
		Subtotals				200	410				
EPA		Effects of Noise on Community Response Related to Annoyance						200			
		Identification of Environmental Noise Levels for Determining Cumulative Dose Exposures for Different Population Segments									
		Subtotals						200			
		Totals for Community or Collective Response	295		410	821	1,114	200	510		

Table F-7
DOMESTIC ANIMALS AND WILDLIFE
(Page 1 of 1 Page)

				Reported Funding, Thousands of Dollars							
Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOA	0057475 SC-00945	The Effect of Noise Pollution on the Fowl	x	x	x						

Table F-8
MEASUREMENT METHODOLOGY AND CALIBRATION
(Page 1 of 4 Pages)

Agency	Project No.[2]	Project Title[2]	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars							
				FY 72	FY 73	FY 74	FY[1] 75	FY 76	FY 77	FY 78	FY 79
HEW/ NIOSH		Industrial Audiometric and Hearing Conservation Technology			31	52	80				

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[1] Estimate.

[2] NIOSH does not use the term "project" for this level of research activity.

Table F-8
MEASUREMENT METHODOLOGY AND CALIBRATION
(Page 2 of 4 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars							
				FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
HEW/ NIOSH		Measurement of Occupational Noise			32	44	28				
		Subtotals			63	96	108				
DOD[1]	DAOD-6739 (USA)	Research on Psychoacoustical Problems Medically Significant to Army Aviation		x	85	195					
	DN-612146 (USN)	Airborne Noise Criteria for Ships and Submarines			69	74					
	DF 313020 (USAF)	Mechanisms of Noise Generation and Reception as Related to Air Force Bioacoustic Programs			3	2					
	DF 313030	Bioacoustic Environments of USAF Aerospace Systems			92	68					
	DF 317570	Bioenvironmental Noise Research Program			4						

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[1] DOD FY 75 data estimated the same as FY 74.

Table F-8
MEASUREMENT METHODOLOGY AND CALIBRATION
(Page 3 of 4 Pages)

			Reported Funding, Dollars								
Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
DOD	DF 314500 (USAF)	Development and Updating of Air Force Land Use Planning Procedure with Respect to Aircraft Noise			32						
	DF 316600 (USAF)	Measurement and Analysis of Aircraft Noise Environments for Developing New Air Force Procedures to Forecast Noise Exposure			13	15					
		Subtotals			337	354	354[1]				
HUD		Hud Urban Noise Measurement System			117	263					
		Development of Noise Attention Measures				175	50				
		Subtotals			117	438	50				

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[1] DOD FY 75 data estimated the same as FY 74

Table F-8
MEASUREMENT METHODOLOGY AND CALIBRATION
(Page 4 of 4 Pages)

Agency	Project No.	Project Title	Total Prior to Initial Year Indicated	Reported Funding, Thousands of Dollars FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79
NASA	504-29-11	Characterization of V/STOL Noises			532	409	404				
EPA	Work at DOC/NBS	Instrumentation and Measurement Systems for Noise Exposure of Individuals			24	32	0				
DOI/ BuMines	S0144091	Portable Calibration Instrumentation for Audiodosimeters--Feasibility Study			0	15	0				
		Totals for Measurement Methodology & Calibration			1,073	1,344	916				

APPENDIX G

ADDENDUM

This appendix is included in the interest of being complete. It contains a project received too late to be incorporated into the report. The project would have been considered in the measurement methodology and calibration category. Fiscal data in the report do not reflect the funding for this project.

Prediction and Reduction of the Noise Impact Within and Adjacent to Army Facilities

US Army Construction Engineering Research Laboratory

Project No: 896-06-001 1 July 1974

1. TECHNICAL OBJECTIVE: To develop methods to quantitatively predict the noise pollution impact of Army operations, including blasting, helicopter operations, industrial plants, and transportation, on civilian and military populations and to develop and assess means to reduce the noise impact of such operations.

2. APPROACH: In conjunction with other Army and governmental agencies such as the Environmental Protection Agency, the means to predict the noise impact of Army activities and/or facilities will be created and tested. The prediction will be a composite of all noise sources and will form "equal noisiness" contours which can be overlayed upon land use maps to graphically expose incompatible zones. Based upon the predictions, operational and physical means to reduce the noise impact will be considered and evaluated for cost, effect upon Army operations, and effectiveness in noise mitigation.

3. PROGRESS: 73 07 to 74 06. The noise prediction model for blast noise has been completed and initially tested. Field noise measurements have been completed on the Army inventory for rotary wing aircraft. When analyzed, this data will go into the Tri-Service Aircraft Noise Impact Prediction Computer Program and enhance the Army's ability to predict noise impact of rotary wing aircraft operations. Construction has begun on unmanned noise monitoring equipment which will be placed in the environs of a facility to test the noise impact prediction technique. Work has been initiated to quantify the human reaction to blast noise into terms and units recognizable and relatable to other noise sources.

4. OVERALL PLAN:

a. The means to predict and reduce the noise impact of military facilities will be created. One physical measure will be used to rate all of the various noise sources from the following classes:

(1) Blast noise;

(2) Fixed wing aircraft;

(3) Rotary wing aircraft;

(4) Mobile equipment;

(5) Fixed equipment and installations.

To the extent applicable, measures recommended by the Federal Environmental Protection Agency will be employed.

b. This work is patterned after Air Force work on the prediction of noise impact from fixed wing aircraft. Essentially an iterative procedure must be followed for each of the above classes of sources (except fixed wing which the Air Force has completed) in order to develop an accurate prediction method.

c. Actually there are two predictions involved; physical and psychoacoustical with the psychoacoustical prediction based upon the results of the physical prediction. Thus, in the iterative testing for accuracy two specific tests must be employed; one for the overall physical prediction, the other for the predicted psychoacoustical response of the community.

d. The following program steps must occur within each class of sources in order to create an accurate prediction submodel for that class.

(1) First of all, a trial noise impact model is created for the class and a computer prediction program is created based upon the model. Initial deficiencies in the data base are identified. These data deficiencies are of two types: psychoacoustical data and physical data which include data about the source, the path, and the receiver.

(2) Documentation is prepared for the computer program explaining its use. This documentation includes creation of a manual that informs facilities of the manner in which they are to compile operational data for submission into the computer program and subsequent generation of impact contours, creation of an operations manual dealing with the use and operation of the program, and creation of a programmers manual dealing with the detailed program description such that other military activities can implement the program at various data processing centers.

(3) Computer generated results are obtained for use by the various installations and for testing the accuracy of the prediction. Based upon the prediction model and the computer program, a manual is created so that the facilities are able to interpret the computer results and can understand the noise impact that their facility creates.

(4) Electronic instrumentation is created which monitors the physical (acoustical) energy arriving to various points in space. This measured energy is compared with the physical prediction. Discrepancies in the prediction dictate the need for alteration of the model and the need for additional physical data.

(5) Community surveys are conducted to assess the community response to its acoustical environment. The results of the surveys are compared with the prediction of the community response. Discrepancies in the prediction dictate the need for alteration of the model and the need for additional psychoacoustical data.

(6) A manual is prepared on the means to lessen adverse noise impact.

(a) These means include a variety of methods such as scheduling changes, location of changes, orientation changes, equipment changes, attenuation structures, attenuation devices, and land use changes.

(b) All of the mitigation methods are evaluated with respect to the attributes of ability to reduce noise impact, cost, and impact on Army programs.

e. As the submodels for the various classes of sources are created and tested they will be combined into a single overall prediction model with its associated computer program and implementation manuals. These manuals are similar in nature to the manuals described above but deal with the entire prediction rather than subclass.

5. WORK TO BE ACCOMPLISHED IN FY 75:

(1) Analysis and reduction of physical data including:

(a) Correlation of 20,000 blast data with 800 weather-sound velocity data points. (December 1975)

(b) Reduction of rotary wing data into raw 1/3 octave data and into units which correlate with human response. (April 1975)

(2) Adapt and create software for using complete rotary wing aircraft data using the Air Force Program as a point of beginning. (Air Force Program only considers frequency above 50 hz - helicopter may peak at about 25 hz.) (February 1975)

(3) Psychoacoustical tests and data analysis including:

(a) Results of rotary wing test. (December 1974)

(b) Results of pilot blast noise tests. (January 1974)

(4) User manual to describe form and presentation of helicopter data to the computer from the installation will be created. (July 1975)

(5) Programmer and operations documentation of the blast noise computer program (contour portion) will be created. (February 1975)

(6) As a special consideration of mobile sources, the effects of traffic noise to residential (barracks and family housing) structures (quantified in distance from traffic areas will be considered using HUD data as a base or point of beginning). (June 1975)

(7) Testing of the physical blast noise prediction will be implemented by:

(a) Constructing measuring system (same as being built for EPA) - our testing equipment will include blast monitoring capabilities while EPA's will not. (January 1975)

(b) Test of the system in the field and evaluation of monitoring results. This will be an on-going activity with periodic evaluations.

(8) Set up for new blast measurement to explore the effects of different climate and terrain. The measurements will take place in FY 76. (July 1975)

(9) Initiate by contract community surveys to assess the response to facility blast noise. (March 1975)

6. WORK TO BE ACCOMPLISHED IN FY 76:

(1) Results of initial social survey/community response with respect to blast noise. (January 1977)

(2) Results of blast noise psychoacoustical tests. (January 1977)

(3) Inclusion of vehicular and fixed sources. (All Year)

(4) Additional blast and possible rotary-wing measurements. (All year, including analysis)

(5) Implementation of blast noise and rotary wing aircraft classes with the DOD manual (omit vehicle and fixed noise sources). (All Year)

(6) Continued base monitoring to test physical prediction. (All Year)

(7) Preliminary attenuation and mitigation work with respect to blast noise and rotary wing aircraft. (All Year)

7. Funding Summary (Dollars in Thousands)

Commitment	FY74	FY75	FY76	FY77	FY78	FY79	To Complete
	CFY-1	CFY	BFY	BFY+1	BFY+2	BFY+3	
In-House	195	175	250	250	250	250	
Out-of-House	35	75	45	45	45	80	
Other	20	10	85	80	80	80	
	250	260	380	375	375	375	450